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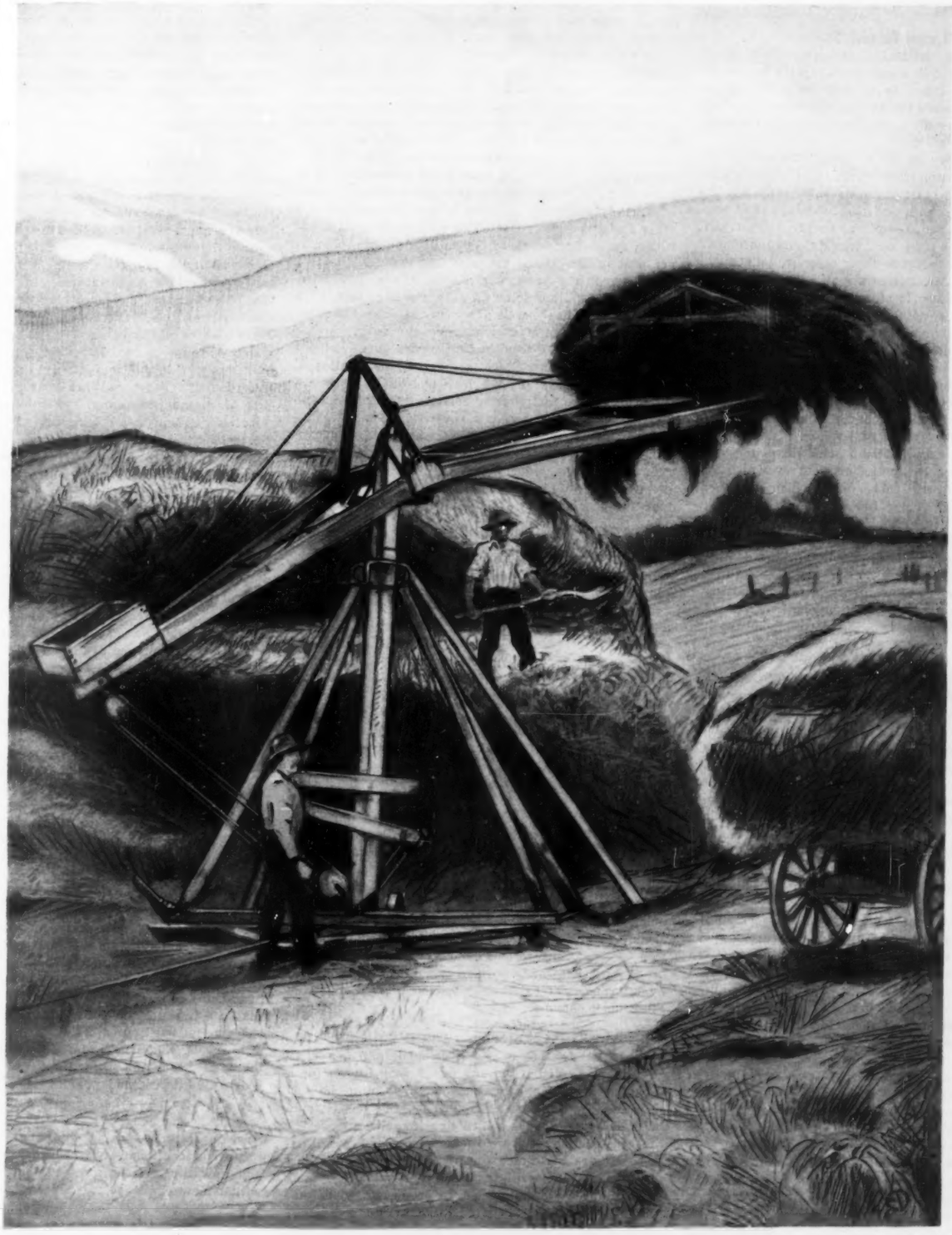

SPEEDING UP THE HANDLING OF HAY WITH THE HAY STACKER

Vol. CXXV. No. 9
August 27, 1921

Published Weekly by
Scientific American Publishing Co.
Munn & Co., New York, N. Y.

Price 15 Cents
20 cents in Canada

SCIENTIFIC AMERICAN

Published by Scientific American Publishing Co.
Founded 1845
New York, Saturday, August 27, 1921
Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary; all at 233 Broadway

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Deep-Level Rapid Transit

IN an age when mechanical achievements of startling character follow one another with increasing rapidity, we learn to be increasingly wary of passing snap judgments upon proposals which, although surprising, are after all merely elaborations of already well-tried principles.

In such a category should be placed the recent suggestion of Mr. Bolton that our future rapid transit subways should be built at levels sufficiently deep to avoid interference with existing subways and gas, water and electric mains—built so deeply, in fact, that the lines could be run on tangents and absolutely free from curves straight to their objective points. As a matter of fact, Mr. Bolton suggests a depth of 400 feet, choosing that low level, we presume, with a view to being able to pass, without grades, beneath the rivers and bays which surround Manhattan and intervene between the island and the outlying metropolitan districts.

The only features that would be strikingly novel in such a system would be the great depth below street level and the consequent great length of elevator travel. For the first condition we may find an approximate parallel in the tube system of London, which is built in the underlying clay and at a sufficient depth to be free from interference by the network of water and gas mains and electric cables with which any great city is encumbered. These tubes are served by elevators of large capacity, although the distance of elevator travel is not nearly so great as that proposed for New York. In this connection we think that the depth of 400 feet is excessive and unnecessary, and in the absence of evidence to the contrary, we think that one-half that depth or, at the most, a depth of 300 feet would be sufficient to clear the deep glacial ravine which forms the ancient bed of the North River and extends out to sea.

The point is well made that by going to sufficient depth it is possible to lay out a system of express subway service, with speeds of sixty miles an hour, in which the tracks could radiate from the business centers of Manhattan and run without curve or grade directly to the outlying districts to be served. It is also true that such a system could be built on larger proportions than our present subways and might be operated with much larger and therefore more economical rolling stock. It is true again that the construction of tunnels at this depth would be far cheaper and more expeditious than our present system of "cut-and-cover," with its costly, laborious and exceedingly troublesome interference with street traffic.

We have a precedent for this type of work in the construction of the 12-foot tunnel for carrying the Catskill waters throughout the length of Manhattan Island, which was executed with unusual speed at a low cost and with complete success. In all probability, the costs involved in the question of easement would be very low. Further precedent for cheap tunnel construction in solid rock is found in the Broadway division of the subway below Washington Heights, which is as much as 130 feet below street level at 181st Street. The most serious problem from the operating standpoint would be that of providing adequate elevator facilities. These, of course, would be costly in construction and in operation, since the cars would have to be of unusual dimensions, and the speed would have to be not less than 700 or 800 feet a minute.

The motive for this bold and original scheme is to be found in the enormous rate of increase of the population of New York, and Mr. Bolton is entirely right in stating that as the years pass by it will become increasingly manifest that subway accommodation of the present near-surface type will be inadequate to carry the population of ten million people, which thirty years from now will be living in New York and its immediate suburbs.

Armaments Offset Reparations

THE close of a modern war, in which the whole citizen strength of the countries involved must be engaged, is certain, should the war cover a number of years, to leave the victors only less impoverished than the vanquished. Moreover, it is the very irony of fate that, in respect to the late war, the nations which won the decision and exacted reparations should today find themselves borne down by military burdens, which just about equal the cost of the reparations which they have imposed.

By the terms of the Armistice and the Treaty of Versailles, Germany, it will be remembered, was disarmed and forbidden to maintain more than a nominal army and navy, or to engage, on any extended scale, in the manufacture of munitions—which meant, of course, that she was relieved of the huge burden, amounting to hundreds of millions of dollars, which is involved in the maintenance of a big army and navy. Financially speaking, this was helpful to her. On the other hand, she was required to make an annual reparation amounting to about 500 million dollars, plus 26 per cent of the actual value of her exports, the two added together representing a total annual obligation of about 760 million dollars. This is a huge sum, it is true, but it is fairly well offset by the financial relief due to the absence of a great army and navy.

The estimate of a total annual reparations indebtedness of 760 million dollars is that of Senator Borah, who, in an article in *The Nation's Business*, draws attention to the fact that from June 30, 1920, to June 30, 1921, the United States spent over 825 million dollars on its army and navy. For the year 1921-1922, we have made appropriations of 830 million dollars, and this would equal in forty years a little over 33 billion dollars. There is no gainsaying the truth of the Senators statement that we shall ultimately pay for our army and navy at the present rate an amount equal to the vast reparation claims against Germany.

We may as well look facts squarely in the face. If we, in common with Great Britain, France and Japan, continue to sink enormous sums in the maintenance of fleets and armies sustained on a scale which is out of all proportion to the legitimate international police necessities of these nations, we are placing ourselves under a financial burden that is practically equal, at least in the case of Great Britain and ourselves, to that which has been assumed by Germany.

It is needless to go once more over the well-known arguments against the present extravagant naval and military programs. We have done that frequently and with all the emphasis at our command during the years which have intervened since the Armistice. Fortunately, and thanks to the great forensic ability of Senator Borah and the far-sighted action of the President, there is to be held in this country a congress whose primary object will be the amicable settlement of outstanding international questions with a view to reasonable disarmament. The success of that momentous gathering, whose first session will take place upon Armistice Day, will depend more than anything else upon the degree to which dissimulation gives place to a sincere desire to look impartially at both sides of every question, and upon a resolute determination by all concerned to leave suspicion and fear outside the council chamber.

The Next America's Cup Challenge

ACCORDING to a recent cable despatch, a challenge will be sent by Sir Thomas Lipton for a series of races for the America's Cup, to be held in 1922. Under existing conditions, the races would be sailed under rules which are intended to prevent the construction of mere racing shells and which, as last year's racing contests proved, failed to do anything of the kind. The rules governing form, beam, draft and sail area were intended to produce a wholesome type of craft which, after it had won or lost off Sandy Hook, could be converted into a staunch cruiser and, as such, be counted on to give several years of service in our own and other waters.

The rule was not, however, a complete failure in this respect, for it worked certain changes in form which were eminently desirable. Thus, the full, long overhangs, characteristic of the scow type, disappeared, and the draft became so moderate that a 70-foot yacht could pass through channels and anchor in harbors without undue fear of grounding. Another good feature of the rule was that it made for greater displacement and a deeper hull, thus providing greater headroom and better cabin accommodations, to say nothing of the improved seaworthiness which comes with increased weight.

To be convinced that the rule failed to prevent the construction of racing machines, it was necessary only to inspect the hulls and spar plans or watch the behavior of "Resolute" and "Shamrock" whenever the wind began to carry any weight in it. For the second time in the history of the last quarter of a century of America's Cup contests, a race was called off because the weather conditions were considered to be too heavy for these frail racing machines to go out and face them. A breeze of 25 to 30 knots is of the kind which used to delight the hearts of the yachting men of the days of Colonel Stephens and of the subsequent era of the two-masted schooners.

It is a matter of history that in the negotiations preceding the "Resolute"-"Shamrock" races, the British challenger tried to persuade the New York Yacht Club to adopt the International rule, in which the actual size of the frames and sheathing of the hull and the character of the spars is specifically designated for every class of racing vessel. The 23-meter "Shamrock," which served as a trial horse for "Shamrock IV," was built under this rule. Not only was she a fast and very "handy" yacht, but her construction throughout was of a staunchness and strength that won the admiration of yachtsmen on this side of the water.

Previous to the races, Mr. Burton came over to this country to try to get the New York Yacht Club to adopt the International rule, which was already in use among the leading yacht-racing nations of the world. The proposal was heartily endorsed by many of the leading yachtsmen, and it looked as though this desirable change would be put through. At the last minute, however, it was rejected, largely because of the violent opposition of the older and reactionary members of the club.

That a rule which calls for strong construction does nothing to take the snap and enthusiasm out of yacht racing has been proved in the series of very interesting races which have recently been concluded in the English Channel between fleets of little 6-meter yachts of American and British design. The boats were built under strict restrictions as to strength, et cetera; and great significance attaches to the contest from the fact that, small as the craft were, they came from the drafting-boards of the most famous and successful designers of big yachts of both countries. The American boats were from designs by Gardner and by Burgess, while the British boats embodied the skill of such men as Fife, Mylne and Nicholson. The five contests were held regardless of weather conditions, and the little boats were sent out in breezes which would have filled the skippers of "Resolute" and "Shamrock IV" with misgiving. With one or two exceptions they came through the series without a mishap, and the fact that they were boats a little stauncher and a little heavier than might have been built under such a rule as governs the America's Cup contest, does not seem to have disturbed any of the skippers or detracted one whit from the keen interest and enthusiasm with which the contest was followed on both sides of the water. The cup was won by the British; but there will be a challenge for next year, and these contests promise to grow yearly in interest and popularity.

We do not know whether any request has been made or will be made that a rule prohibiting the use of absurdly light scantling and spars be adopted for future international races between yachts of 70 feet and upwards. If the matter comes up in connection with a new challenge, we sincerely hope that it will receive most serious consideration. The New York Yacht Club should hesitate to stick to a rule which produces a pair of boats which are afraid to face a summer breeze of more than very moderate weight.

Engineering

Watt's Workshop.—In James Watt's attic workshop at Heathfield Hall, near Birmingham, his tools still lie just as he left them a hundred years ago. The owner of Heathfield Hall recently died, and the Watt Centenary Committee now purposes to take steps to preserve this sanctuary of science to the British nation.

An Absorption Plant is being erected on the Dingman No. 1 well near Okotoke, in Alberta, for the purpose of absorbing gasoline from wet gas which is blowing out of the well at the rate of between two and three million feet daily. So heavily is the gas at this well laden with oil that when the tap is taken off and the gas comes roaring out the minute globules of oil form a bluish-gray column projecting several inches above the mouth of the opening.

Rhone Development.—The French have some ambitious plans for the development of the Rhone River. It is planned to make this waterway into a water transport line that will rival the Rhine and will serve for the irrigation of over 600,000 acres of land. Also, 900,000 kilowatts of cheap electric current is to be made available, thus saving coal imports to the value of at least 600 million francs a year. River ports will have to be improved or at need, created and joined by rail with the main land arteries of traffic. The Rhone River flows west and south from Lake of Geneva to the Mediterranean Sea.

Hongkong's Engineering Projects. — Tenders have already been invited for a reclamation scheme at Hongkong, which involves the reduction of Morrison Hill, at the eastern end of the city, and the filling in of tidelands near the heart of the business section. Some 3,300,000 cubic yards of earth will be handled and about 90 acres of land reclaimed from the sea, in addition to the land made usable by reduction of the hill. The fill to be made, states the *Trans-Pacific*, will involve the construction of a sea wall about a mile in length, from which piers and docking facilities of concrete and stone will extend into the sea.

Concrete Masts for Radio.—The Japanese Government is building a powerful radio station at Tokio, one striking feature of which is the reinforced concrete tower for supporting the aerial. The tower is 672 feet high, and of a round, tapering form. It measures about 50 feet in diameter at the base, and about four feet at the top. The structure is hollow, of course, with reinforcing bars throughout. The center hollow of the concrete tower is occupied by a steel stairway, which gives access to a balcony near the top, and to four other balconies. The tower was cast by means of a central framework of wood and outside wooden molds, which were shifted upward as the casting progressed.

Government Investigation of Building Methods. — With a view to simplifying and even unifying the building codes of the many cities throughout the country, the United States Bureau of Standards has been conducting a most interesting and valuable series of tests on building materials and methods of construction. Brick walls of various kinds have been subjected to compression and fire tests; various kinds of plaster have been made up and subjected to rigid tests; stone, concrete and other building material have been alternately frozen and thawed out until they have cracked, and so on. The intention back of all these tests is to formulate a standard building code which may be adopted by the various municipalities throughout the country. It is believed that with a unified building code it becomes possible to lower the cost of building construction. An article on this interesting subject will appear in our columns at an early date.

Humidity and Sound Absorption. — The absorption of sound by a massive rigid wall has been shown to be due in large part to the dissipation of energy in the pores of the reflecting surface. Absorption due to this cause increases with the frequency of the sound. Walls of ordinary plaster have been found to show slight increase in absorption with aging, due presumably to increased porosity. A marked decrease in the absorption by the walls for sounds of high frequency with large increases of humidity in the room, has been observed, according to the *Physical Review*. Thus walls of hard gypsum plaster were observed to show a gradual decrease in absorption coefficient amounting to 25 per cent of the original coefficient for the tone 4096 when the relative humidity in the room was increased from 45 per cent to 85 per cent. Weighing of a small sample of the plaster showed that in a humid atmosphere an amount of water equal to one-half of 1 per cent of the weight of the sample was taken up. The closing of the minute pores in this way will account for the decreased sound absorption since the latter decreases with decreasing size of the pores.

Science

A Twelve-Ton Cheese.—A cheese is being manufactured for exhibition at the New York State Fair in Syracuse. It will weigh 12 tons and will require 150,000 pounds of milk, or a day's output of 7500 cows.

Meteorite Fall.—A large meteorite fell a short time ago in the grounds of Salop County Asylum, England. Dr. Hallsworth, one of the medical officers, saw it drop into a bush. It was quite hot when picked up, and porous and light as pumice-stone.

Heavy Storms in Switzerland. — This has been a strange year for Switzerland, first the drought, then the severe snow storms which sent Alpine climbers to the shelter huts. From 20 to 30 inches of snow fell in some places about the 6,000 foot level. The thermometer dropped 30 degrees.

Florida Plans to Cultivate Grapes. — The Florida Grape Growers' Association was recently organized at Lakeland, Fla., by sixty-five growers. It is expected that the 1921 crop for the State will amount to 100,000 pounds. Some growers have already contracted for their yield at 35 cents a pound.

Ceylon Graphite.—In the Island of Ceylon graphite is found in greater abundance than in any similar sized area in the world. The soil and rocks of Ceylon are almost everywhere impregnated with graphite, so that it may be seen covering the surface in the sewers after a rain. The supply is practically inexhaustible. The peculiarity of Ceylon graphite is its extreme purity.

German Chemists Active.—The International Frankfort Fair, recently held in Germany, was remarkable for the number of new chemico-technical products which were placed on exhibition, showing that the manufacturers of that country are intent not only on developing some of their well-known products, but are also busy devising new articles with which to build up their trade.

Big Bed of Ochre.—A substance resembling brown coal, found within twenty-four miles of Guatemala City, and within fifteen miles of the railroad, has been found to be ochre, which when mixed with water and lime produces a good quality of paint. It is believed by the Department of Foreign and Domestic Commerce that an excellent business might be built up in this material. The supply appears to be very large.

New Process of Aluminum Manufacture. — An important discovery, a new method of extracting aluminum from a mineral, which affects the future development of Japanese industry and the formulation of an established air policy of the Japanese Government, is the result of the investigations, which have been carried out by the experiment station on the production of aluminum and its compounds. A great refinery plant driven by electric power will be established at Yoyogi. A project is under contemplation to establish a semi-governmental company for the manufacture of aluminum by the new method, which consists in the electrical treatment of ore and enables the production of aluminum to be increased.

Ever-Bearing Orange Tree Found at Tampa. — An ever-bearing orange tree which citrus fruit growers believe is destined to revolutionize the orange industry of the state of Florida, if not of the entire country, has been discovered by horticulturists in a small grove at Avon Park, near Tampa, and to protect the specimen its purchasers have placed around it a heavy wire fence twenty feet in height and stationed guards day and night. The tree has been in bearing continuously eight years, but until recently its existence was known only to the owner and several neighbors, who, according to citrus experts, did not realize its value but regarded it merely as a freak of nature. A syndicate has been formed to propagate the tree through budding so that a large number of trees may be set out in groves in 1923.

Eclipse of Rhea by the Shadow of Titan.—Occultations of one satellite by another have been rather frequently observed, but there are very few recorded cases of the eclipse of a satellite by another's shadow. Webb, in his "Celestial Objects," says there is only one such case on record in connection with the satellites of Jupiter. Much interest therefore attaches to the eclipse of Rhea by the shadow of Titan observed by several astronomers April 8, 1921, in consequence of a prediction of the event published the previous January by Messrs. Comrie and Levin in the *Journal* of the British Astronomical Association. Rhea was completely invisible for more than half an hour. The observed time of mid-eclipse differed by about 9 minutes from the predicted time. The records of these observations, when fully worked up, should afford a valuable check upon the existing tables of the two satellites of Saturn above mentioned.

Automobile

Gasoline Sources. — According to one authority, about 75 per cent of the gasoline produced in the United States is obtained by direct distillation from the crude. About 10 per cent comes from natural and casinghead gas, while only 15 per cent is produced by cracking processes.

British Gas Distribution. — Gasoline filling stations for automobiles have not come into use in northeast England and garages use "drum storage" and hand-filling methods in the handling of gasoline. A great majority of automobile owners buy their gasoline in drums, keeping it in their private garages, while public garages carry only enough to suffice from day to day.

A Mark of Careless Design or assembly is the pool of oil left on the garage floor or roadway by many cars even though they be new and presumably in good repair. A floor pan is required in many cases to prevent the floor of the show room from becoming stained, while our highways are black with oil dropped from cars and trucks which use them. A dollar a gallon is, one would think, a rather high price to pay for road oil, yet that is about what the average motorist pays for oil, a large proportion of which is ultimately deposited on the roadways wherever cars are used.

A Instrument Board for installation on top of the steering wheel has been developed and is being manufactured. The speedometer, oil gage, ammeter, ignition and lamp switches and any other indicating mechanism normally used in car operation may be mounted upon it, leaving the space ordinarily used for the instrument board and its connections free for storage compartments for gauntlets, lamp bulbs, spark plugs, curtains or any of the numerous other things that motorists like to carry on the car in a handy place. The control board is flush with the steering wheel and all of the indicating devices are directly in the line of vision of the driver, which is certainly a convenience.

Gasoline In Smaller Demand.—Price cuts failed to make any material difference in volume of gasoline consumption as the Bureau of Mines refinery statistics for February show that the daily average of gasoline production fell off by one million gallons but the stocks increased by 108,000,000 gallons. The lessened demand was also reflected in increase of 18,000,000 gallons of lubricating oils in reserve with a decreased production of 185,000 gallons. The figures show that there were 680,540,351 gallons on hand at the end of February. Exports amounted to 52,497,051 gallons; shipments to insular possessions, 4,536,619; and domestic consumption, 225,195,372 gallons. The daily average consumption was 10,079,609 gallons.

Drop-Forged Auto-Wheel a Newcomer.—The latest addition to the large variety of automobile wheels is the drop-forged steel wheel which is said to have a number of advantages to warrant its use. At the present time, it is made chiefly as a replacement for several types of small, low-priced popular cars. As compared with wood wheels, the forged steel wheel has the advantage that it consists of only a single piece and therefore has no joint to come apart. Being made of wrought steel, it is practically unbreakable. Even the brake drum is made in one piece with the wheel and where it fits to the spokes the joints are nicely rounded so as to prevent the accumulation of mud and dust at these points. All trouble due to the shrinkage of wood is eliminated, and if the wheel is made true in the first place, it should remain true. The drop-forged steel wheel is easy to clean and should prove particularly popular in arid sections where wood wheels give trouble owing to shrinkage.

New Positive Drive Differential.—A positive-drive differential of the sinusoidal type designed by A. T. Nogrady has been the subject of investigation by various concerns in the industry. The differential is fitted with the bevel pinion and side gears in the usual manner. However, the bevel gears are fitted with either helical splines or sinusoidal cams that engage with external and internal members, the latter a portion of a member fitted to, or integral with, the main axle shaft. When the traction in either of the rear wheels varies, a cam tends to thrust the differential bevel gear, or side gear against clutch faces on the housing, thereby setting up a frictional load which is transmitted to the cage as a torsional load, and thus to the main axle shafts driven by the side gears. When operating under ordinary conditions, the effect due to the cam is to thrust the side gears inward and away from the provision for positive driving friction, and since the clutching faces are brought to bear one against the other, the thrust is equaled between the inner and outer clutching faces.

Pennsylvania's Roads

The Comprehensive Highway Engineering Plans of the Keystone State

By William McGarry

AN engineering feat far greater in total outlay of funds than the Panama Canal is going on quietly in Pennsylvania. Hardly anything is heard of it except when some unlucky motorist gets mired down in a detour over one of the execrable roads that the Keystone State is rushing to replace with what will be the finest highway system in the world.

To date Pennsylvania has built and has in service more than 500 miles of reinforced concrete road built to carry loads of 13,000 pounds, more than 100 miles of road made up of a concrete base with bituminous top, or plain concrete; more than fifty miles of brick road, and an equal stretch of sheet asphalt and new macadam highway.

The proportions here offer a fairly good indication of what the state is attempting to do, for the same ratio of reinforced concrete will govern in the construction of a primary system of highways to cover eventually more than 4,000 miles. At the present writing about 750 miles of this work is under contract and the state, which already claims the world's record for permanent, high-speed road building, is out to set a new figure which may stand for years.

With conditions of labor and material markets vastly improved over those existing last year, it is a foregone conclusion that the record made in 1920 will be exceeded. In that year, despite shortage of labor, lack of materials, and increases in cost that forced the abandonment of many similar projects, Pennsylvania forged ahead and completed a total of 413.87 miles of durable thoroughfare.

Work had been started at the close of the season last year on an additional 450 miles of highway, which the Department was unable to finish because of the coming of winter. It is planned to add to this contracts for a total of 400 miles this summer—in fact, 300 miles already has been let and work has been started. Before the end of the summer many through routes will have been completed and open for service.

The entire cost of the "primary system"—laid out so that it will be possible for a citizen in any part of the states to reach any other section over it—is being borne by the state. For this and other road work in its program the Highway Department has available more than $125,000,000, including bond issues and appropriations, and Federal funds. The bond issue is $50,000,000.

Perhaps the most remarkable feature of the Pennsylvania plan is that every mile on the new primary system of highways was put there only after a thorough survey. This was made over existing routes to determine their availability, locally and to the state at large. In every instance, when it was found that a road by many windings was serving local interests at the expense of the entire state, changes were made in the routing.

In some instances miles of old road were abandoned, so far as the new state highway plan is concerned, so that new concrete highways might be laid on lines as nearly straight as possible. There is hardly a road in the system crossing a hill of any consequence in which the grade has not been changed, sometimes at heavy cost. The whole thing is worked out by engineers equipped with a knowledge of the pulling power of motor trucks and other traffic for which these roads are being built. Pennsylvania is trying to build a highway system on which no vehicle will ever get stuck save as the result of a mechanical defect. Grades are made passable.

The importance of this will be instantly apparent to motor truck experts who have tried to send heavy loads over some old country highways. It must not be assumed, however, that because the Department is taking advantage of every possible short cut and makes deep cuts through hills that it has ignored the value to the state of preserving the scenic features of its roads. The new system will open to modern motor travel some of the loveliest spots in the state, heretofore closed to those who refuse to take chances on wrecking their cars. It will open also the hunting territories in the western section and hill regions where few cars ventured in previous years.

The primary system does not include many hundreds of miles of road, some of it of the heavy reinforced concrete type, being built in cooperation with county authorities and the Federal government. In general, the state's system includes through highways, and roads connecting the various county seats. Particular attention has been paid in the surveys of through routes used for long distance hauls to the matter of short cuts. An idea of what has been done here is evident from the fact that the Lincoln Highway from Trenton to Philadelphia has been reduced about two and a quarter miles by the elimination of unnecessary curves and loops.

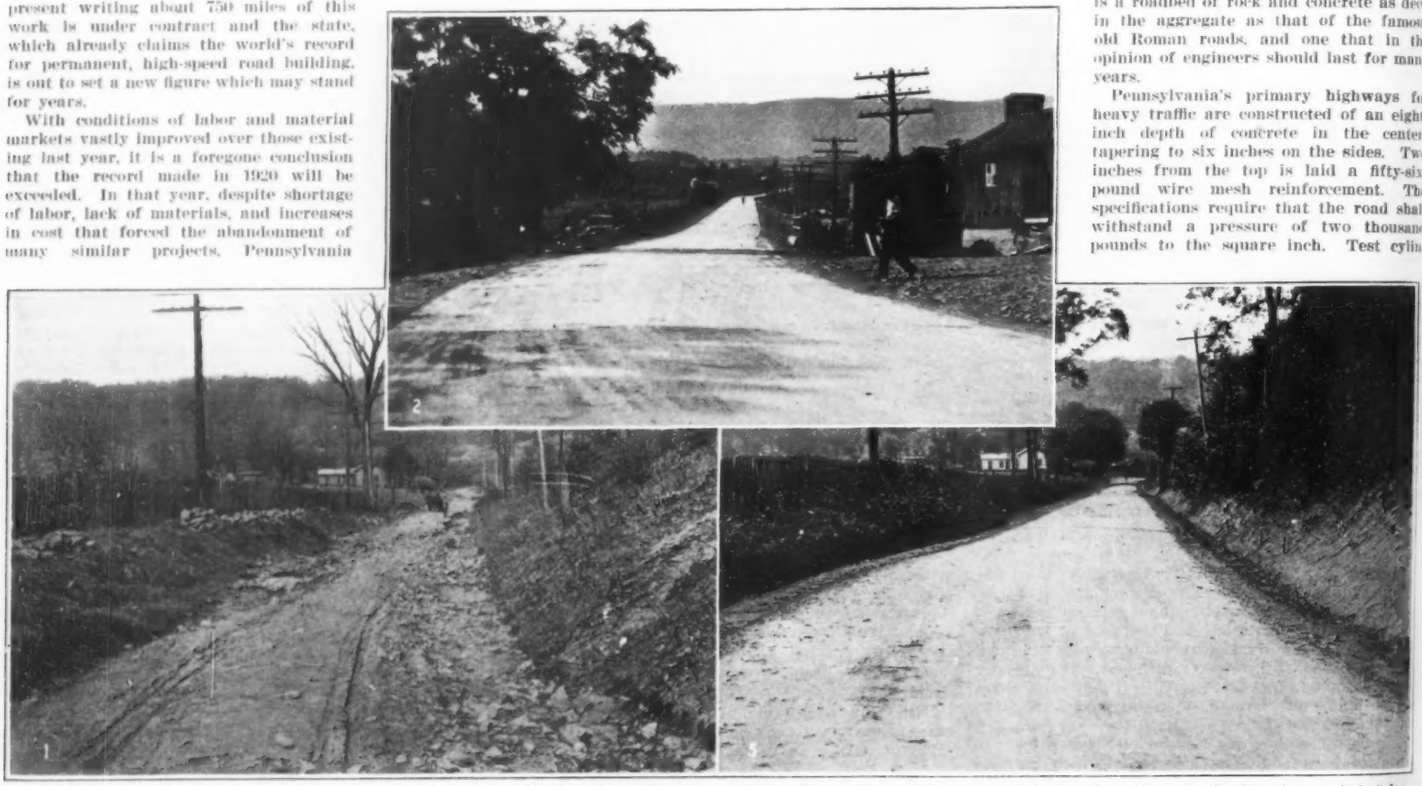
One of the best things about the new system is that it is eliminating many of the most dangerous grade crossings. There were two of these on the Lincoln Highway near Langhorne, Pa. Both have been eliminated in the new survey. The old road looped at this point and made two crossings. By straightening out the loop it was possible to do away with both crossings by a single undercut of the railroad track.

Highway engineers throughout the country have been watching some of the roadbuilding in the Keystone State with unusual interest. For instance, the greater part of the new concrete road from Philadelphia to West Chester, a distance of twenty-one miles, which is nearing completion at this writing, is laid on the old macadam road. This old road was in a bad state of repair. It was leveled off to form the foundation for the concrete. The result is a roadbed of rock and concrete as deep in the aggregate as that of the famous old Roman roads, and one that in the opinion of engineers should last for many years.

Pennsylvania's primary highways for heavy traffic are constructed of an eight-inch depth of concrete in the center, tapering to six inches on the sides. Two inches from the top is laid a fifty-six-pound wire mesh reinforcement. The specifications require that the road shall withstand a pressure of two thousand pounds to the square inch. Test cylinders are taken by inspectors employed by the State Highway Department every 1500 feet and sent to Harrisburg for examination. Expansion joints are laid on straight runs at the end of each day's run, and at all points of grade or curve where they may be considered necessary.

Last year the concrete was fed into the big mixing machines by gangs of shovelers. Examination of test cylinders, and of sections broken from cracks appearing in the finished road, convinced the State Engineers that most of the failures of the construction were due to the mixture of dirt and occasionally debris in the concrete, as when a gang cleaned up the roadbed preparatory to moving the machine. Accordingly, the specifications this year provide that there shall be no dumping of anything on the subgrade. Cement in bags, heretofore stacked on the grade, is now carried alongside the right of way. Most of the contractors at work on the state highways now use one-ton trucks for the concrete materials. These are loaded in two sections with just the right proportions of stone and sand. These essential materials are dumped directly

(*Continued on page 155*)



1. A strip of typical Pennsylvania road before the automobile era. 2. A bit of the Lincoln Highway in Fulton County, Pa. 3. The same stretch of roadway shown in the first view, as it is today

Pennsylvania's roads before and after taking the treatment prescribed by the State's highway engineers

Left: A detail of the penstock on a grade of almost 100 per cent. *Center:* Anchoring the penstocks. *Right:* The big turbines and generators in actual operation

Views along the line of the Caribou power development

The Caribou Power Plant

By C. W. Geiger

THERE are many unusual features in connection with the new Caribou power plant recently placed in operation in California. Aluminum cables, nearly one inch in diameter, transmit the power generated at this plant over double-steel-tower transmission lines 186 miles to the San Francisco Bay distributing area. The voltage is 165,000, the greatest voltage that is now carried on any transmission system in the world. Lake Almanor, from which the Caribou plant will draw a part of its waters, is the largest artificial power reservoir in the world. The submarine cables that deliver this power to San Francisco from across the bay, are the longest submarine cables of this voltage in the world.

The power development area of which the Caribou plant is a unit, begins in Lake Almanor, the source of the Feather River, and ends 75 miles distant, a drop in altitude of more than 4000 feet. The whole project in a nutshell consists in using the waters of the river over and over again during this drop (seven times) for the generation of hydro-electric power, and finally distributing them for irrigation when they have reached the Sacramento Valley levels.

Through the power thus developed there is now furnished more than 300,000 hydro-electric horsepower for California agriculture, business and industry, including mines, factories, gold dredges, railroads, commercial and domestic lighting and coking and heating. Practically all of this service has been connected within ten years, and probably within the next fifteen years the Feather River development will reach 640,000 horsepower.

Because the Caribou power project was undertaken on the very heels of the cessation of World War hostilities, Central California is saved, this summer, the losses suffered from the power shortage of 1918, 1919, and 1920. Of even larger importance, this great area, with its rapidly increasing population, may go forward confidently in the development of its resources, knowing that, as the need arises, power and more power may and will flow to it from the perpetual reservoirs of the mountains. An interesting sidelight is found in the circumstance that where the Big Bend power house—the largest hydro-electric power plant west of the Mississippi—now stands, the waters of the Feather River were first diverted so that the sands of the river bed might be washed free of their golden weight. The very tunnel used for this purpose eventually became the power-house diversion tunnel.

To feed the new Caribou power plant with water was in itself an engineering undertaking of magnitude. Tunnel No. 1, 11,200 feet long and with a capacity of 800 cubic feet of water per second, was built to carry the waters of Lake Almanor regulated by two seven-foot electrically controlled gates, into Butt Valley, down which they course to Tunnel No. 2, 9200 feet long and with a capacity of 1400 cubic feet of water per second, which leads them to the pressure tunnel. At the bottom of the pressure tunnel, a horizontal tunnel 550 feet long, carries at the present time two sixty-inch steel penstocks which are attached to the pressure tunnel and made water tight by means of a large concrete plug. There is space in the horizontal tunnel for a third pipe of similar dimensions. The pipe lines emerge from the horizontal tunnel and are anchored on the surface of the hillside a distance of 547 feet to a point where they drop vertically into another tunnel known as the "uprise," which is about 550 feet deep. About half way down the "uprise" the sixty-inch pipes, by means of large Y-connections, branch into four forty-two-inch pipes. A tunnel running horizontally from the bottom of the "uprise" carries the pipe lines about 500 feet to the surface of the mountainside immediately back of the power house. From this point the pipe lines are laid on concrete anchors to four hydraulically operated gate valves which are installed against the rear wall of the power house. From these valves the pipe lines lead into the power house, directly to the nozzles of the water wheels. Space has been left in the "uprise" and horizontal tunnels for two more 42-inch pipe lines.

The two 30,000-horsepower units installed at present consist of two overhung impulse wheels, each with 21 buckets, operating under a head of 1008 feet, with a speed of 171 revolutions per minute. Each of the buckets of these wheels weighs 1000 pounds. The diameter of the jet which strikes them is eleven inches. These wheels and generator constitute a unit. Each unit weighs 290 tons. The revolving element of each unit weighs 170 tons.

The Soap-Nut Tree—A Last Chance

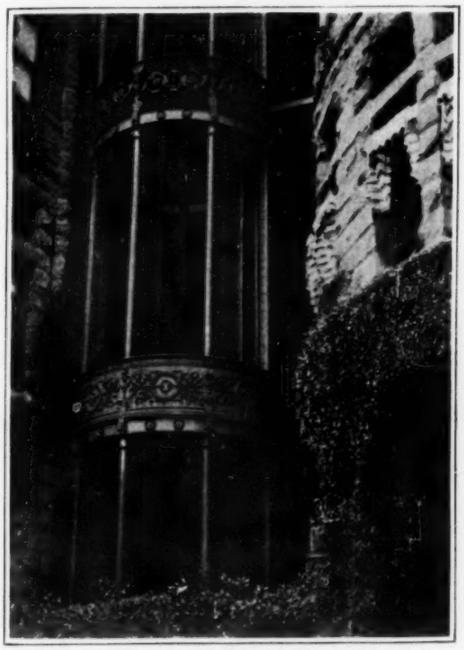
OUR old friend, E. Moulie, who used to be in Florida, but who is now established in San Gabriel, Cal., asks us to assist him in what he believes will be his last distribution of the seed of his beloved soap-nut tree. This tree, *Sapindus Muskorossi*, to give it its botanical name, is some fifty feet tall when fully developed, and quite ornamental. Its timber resembles orange wood. It bears from the age of six years, the average crop being about 200 pounds of nuts per tree. These nuts are altogether extraordinary. It is the shell of the nut that gives the tree its name; this shell is so rich in saponaceous material that the uncracked nut, right from the tree, can be used with excellent effect to wash the hands. This saponine of the hull washes everything from a lace handkerchief to a horse blanket, and is highly beneficial to the human skin as well as to the scalp. Inside is found an edible kernel, extremely rich in fats and high in food value.

Mr. Moulie has spent a good part of his long life (he is in his eighty-first year) in the effort to bring the soap-nut tree into more general cultivation in all places that are suited to it. On several occasions, after he has succeeded in accumulating from his own plantations a supply of the nuts sufficient for the purpose, he has conducted free distribution of the seed, with great success.

The soap-nut tree will not prosper in regions where the thermometer may be expected to drop below ten degrees, Fahrenheit, and Mr. Moulie will not send seeds to such localities. With this exception he is eager to have applications for the seed from any part of the world. The last time he distributed the seed he had so many requests that the labor and the expense of filling them nearly swamped him. He therefore insists that all applications be accompanied by self-addressed stamped envelope, plus ten cents to cover clerical work, etc. In return each applicant will receive ten tested soap-nut seeds, which will be sufficient nucleus for an extensive orchard. Mr. Moulie suggests that applicants from foreign countries send the ten cents in international postage coupons if United States stamps are not obtainable.

The seed will germinate sooner if planted in a hot bed, in a box or pot. The seeds should be planted 1½ inches deep and the soil about it kept moderately moist. When the seedling is about 18 inches tall it can be planted at the point in the open where it is desired to have the tree. It must be placed at least 25 feet from any other large tree, and the soil again kept moderately moist until the roots are well settled and the tree has started a healthy growth.

It is to be emphasized that Mr. Moulie's object in asking us to make this announcement is to spread as widely as possible the cultivation of the tree over which he is so enthusiastic. His distribution of 1918 was marked by numerous requests for the nuts in such quantities that it was plainly the intention of the applicants to use them for soap or for food—one lady actually asked for instructions as to their preparation for the table. Mr. Moulie is giving away seeds, not food; and he is giving them in such a way as to give them the maximum circulation. He will not undertake to acknowledge any letters that do not meet his conditions. In particular, do not ask for his nuts by the pound or the bushel; the supply is not unlimited, though Mr. Moulie believes it is large enough to insure ten of the tested seeds to everybody who wants them. But from the figure which he names in his letter, if you are the 6001st applicant you may not get any seeds.



The out-of-doors elevator that was added to two Los Angeles buildings

How the Elevator Was Added

THE solution of the elevator problem for two public buildings in Los Angeles, two buildings that were built side by side, was an out-of-doors elevator. It was put up at the same time that the passageways from one building to the other were installed. This type of "open-air" car is possible owing to the lack of inclement weather and makes it possible for both buildings to be served by one system. At each landing there is a door into each building, and the elevator car is fitted with a door at each side. In addition to its practicability this style of system enables passengers to view the city, as the buildings are on the summit of a high hill.—By *C. A. Goddard.*

A Problem and Its Attempted Solution

The Filing of Papers, as Improved by the Inventive Talent of Our Patent Office

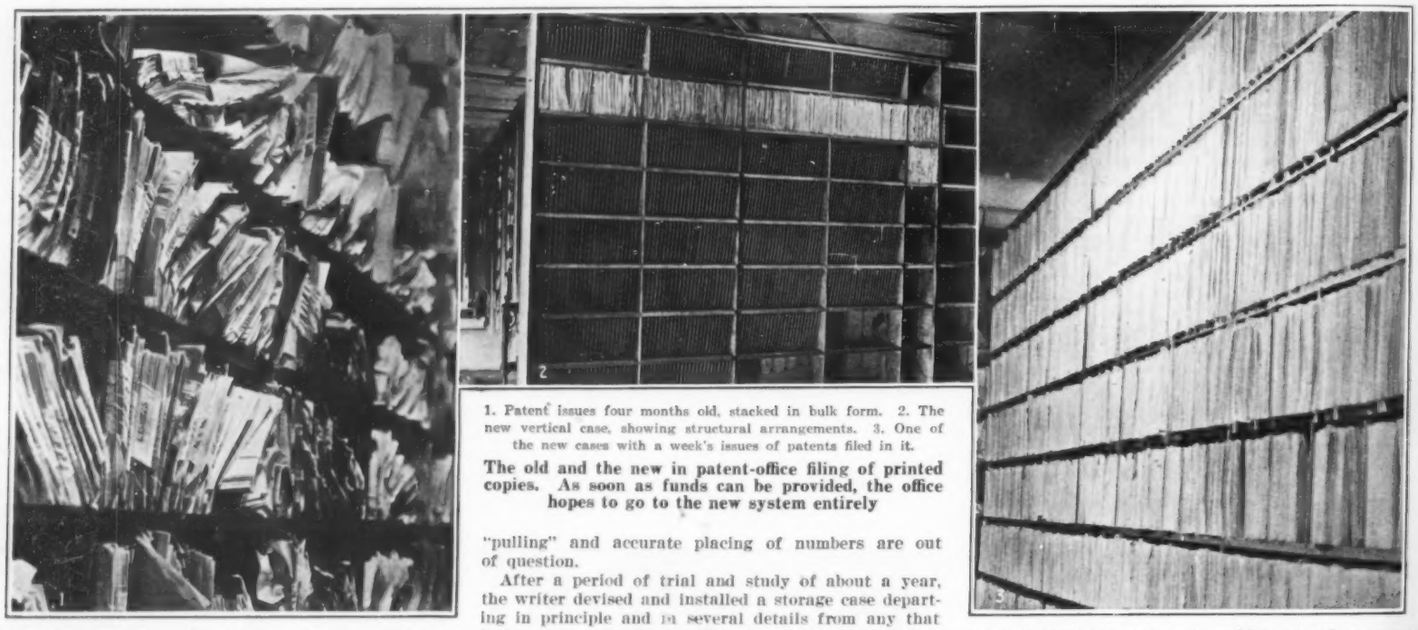
By Wm. I. Wyman, Chief Clerk, U. S. Patent Office.

DUE to the sudden and remarkable increase of business before the Patent Office in the spring of 1919, the restricted force of employees therein, and the archaic method of storing copies of patents for sale, a situation arose which caused widespread inconvenience to very important interests. These copies of patents represent, in one body of literature, the nearest approach to a complete history of our industrial advance and to a self-sufficient compendium of all knowledge in the arts of material achievement. For practical purposes, they are nearly indispensable, in the investigation of technical problems, in the ascertainment of rights in industrial property, in the conduct of business with the Patent Office, and in litigation before the courts. The breaking down of this service became truly a critical question, whose solution could not be postponed without evident aggravation of a situation already almost unendurable.

A slight increase in the force granted by Congress in the last part of 1919 permitted an attempt at relief. In the January 17th number of the SCIENTIFIC AMERICAN appeared an article relating to this subject which depicted graphically the fallen state to which this service had descended. As shown in the pictures accompanying that article the copies of patents were stored on open wooden shelves, wrapped in muslin bands, without means to sustain them in place or properly to identify them, or make certain their position in regular order. Lack of equipment and lack of previous opportunity to develop a comprehensive plan had brought the condition depicted to pass.

In the fall of 1919 Commissioner Newton impressed upon the Chief Clerk of the Office the necessity for action and, in view thereof, a comprehensive survey was made and a general procedure outlined. It was found that the copies were stored in no sequential order, but in broken groups without numerical relation to each other, from cellar to attic, and in every wing of the building but one. This was due to the fact that only such space could be acquired as was released by the Interior Department, which occupied until a few years ago such portions of the building it deemed necessary for its own purposes. There were found 37 groups in scattered arrangement, and the attempt was made to reduce the groups to as many units as there were physical divisions to contain them. Meanwhile, the copies were straightened out, connected in sequential order, and brought from and carried to all parts of the building to be assembled in proper groupings. Out of the 1,400,000 bundles of patents contained in the building, about 900,000 have thus been finally allocated. In a portion of the west balcony, for instance, a wing 270 feet long contains a quarter million bundles of patents in so-called "bulk" form, without a break, running consecutively from No. 1 to No. 250,000.

It is evident, however, that this "bulk" system of storing patents is contradictory of modern methods, that the equipment is inadequate and unscientific, and there is bound to result waste, inaccuracy and inefficiency. To keep this system at all effective, constant vigilance is required. For a time after their receipt from the printer the copies stored in this fashion are freshly arranged and illustrate the conditions of the present method of storing at their very best. They stand up well and the numbering on the muslin bands or wrappers is clearly displayed. But this favorable appearance is not for long. The sale of copies as soon as published proceeds very rapidly, the stock is soon depleted, and after repeated "pulling" of copies from a given bin the condition shown in Fig. 1 soon approached. That figure illustrates the condition of the copies from three to four months old, after which time the bundles are "pushed back," i. e., closed up, and straightened. It is needless to state that considerable labor is thus entailed and wasted; and that until the copies have been "pushed back," efficient "pulling" and accurate placing of numbers are out of question.



1. Patent issues four months old, stacked in bulk form. 2. The new vertical case, showing structural arrangements. 3. One of the new cases with a week's issues of patents filed in it.

The old and the new in patent-office filing of printed copies. As soon as funds can be provided, the office hopes to go to the new system entirely

After a period of trial and study of about a year, the writer devised and installed a storage case departing in principle and in several details from any that had ever previously been tried. Cases divided into small compartments to hold copies of but one serial number had been suggested and, in fact, are being used to some extent for this purpose. But it was necessary to discard the installation of further of these units, called "individual" cases, as they possessed grave defects which a limited trial disclosed. Patents vary greatly in thickness, in the great majority of instances from two to ten sheets. There is thus a disparity in the space occupied by any bundle possessing the same serial number, not only on account of the varying thickness of the copies, but also on account of the variation of the sales of copies. These old "individual" cases were, therefore, designed with horizontal compartments, deep enough to receive any bundle except the very bulkiest. With the larger bundles determining the size of the individual compartments, necessarily a decided waste of space occurred, the excess of space occupied over the bulk form of storage amounting to about 75 per cent. In spite of this disadvantage and the fact that the upper, exposed copy collected dust, this case was a decided improvement over the "bulk" arrangement. In the latter, three movements are required for the "pulling" of a copy. The bundle must be withdrawn outwardly, the copy wanted pulled out at right angles from its wrapper, and the bundle then pushed back. In the "individual" case, each compartment holds but one number, there is a distinct place for each copy, and but one movement is required to "pull." But, as stated before, the installation of the "individual" cases had to be discarded. It literally ate up space, which was, and is even still more, at a premium in the Patent Office.

A year's trial with various styles of shelving convinced the writer that the broad idea at the basis of the "individual" case was the germ of any successful attempt to solve the problem that has baffled the officials of the Office for over a generation. With the desideratum of economizing space ever in view, it was finally determined that a solution depended upon a hypothesis diametrically opposite to the one that had hitherto been utilized. Instead of making the dimension of the compartment dependent upon the size of the larger bundles, it was made dependent upon the space occupied by the *smaller* bundles. It was evident that with the smaller bundles determining the size of the individual compartments, practically the entire space of these compartments would be occupied, and that the problem of avoiding waste space was solved. The obvious objection to this scheme was met by another and still more radical departure; the arrangement of open spaces in the same case, where the excess of "fat" copies "squeezed" out by the reduced size of the individual compartments could be stored as reserve stock.

Fig. 2 shows the details of one of these cases. The framing is made of wood, the horizontal shelving being slotted for the reception of galvanized-iron vertical partitions. Some of the units are shown before these partitions are slid into position. One horizontal row of copies has been placed, containing one hundred numbers of about 3000 individual copies. It will be noted that a vertical column of free-space compartments is left to the right of the partitioned shelving. This is for the overflow, which is seen to be occupied by wrapped bundles, and which will comprise about 10 per cent of the contents of the case. Under the worst fortune, the volume of this overflow compartment will represent the wastage of space as compared to the old "bulk" arrangement when the latter is at its best and in "dressed up" condition.

An interesting feature of the construction relates to the vertical partition or divider. In the horizontal "individual" case, it had to support the weight of the bundle superposed on it. In this new case it has no structural function and can, therefore, be made very thin, thus saving considerable space. The special novelty in the divider is its trapezoidal form. This permits the grasping of the copies and avoids the expensive operation of cutting away the usual segmental portions for that purpose. Also no metal is wasted, and the facing edge can be hemmed or beaded by a simple mechanical operation.

Fig. 3 illustrates the first case installed from

(*Continued on page 155*)

Left: Using an elaborate receiving set for reading long-distance radio messages. A kite, carrying a copper wire, is flown from the canoe and serves as the aerial. *Center:* A large man-carrying kite being prepared for a flight with a radio aerial. *Right:* A small gas balloon being sent aloft with a copper wire to serve as an aerial

How kites and baloons may be pressed into service for putting up the temporary radio station

The Ubiquitous Radio

By Arthur Lynch

PROGRESS has been remarkably rapid in radio telegraphy, and little less than astounding in radio telephony. By far the greatest fascination in amateur radio has been brought about by the almost unbelievable development of the radio telephone; for, had it not been for this, amateur radio would still be confined to those either understanding the telegraph code or willing to master it through persistent practice. Whereas, up till the recent past the ordinary layman simply heard a jumble of meaningless dots and dashes when listening to radio activities, today the same layman can hear wireless music and regular conversations which need no translation of any kind. The radio telephone has made radio interesting to everyone.

The number of radio telephone stations in regular operation is truly surprising. The reason for this rapid growth is simple enough. Until the practical development of the vacuum tube, which in its main essentials is simply a form of incandescent lamp with a number of additional elements introduced into the glass bulb, there has been no simple method of generating radio waves for the transmission of speech. The cumbersome and sputtering arc, the highly expensive and intricate high-frequency alternator, and other old-time methods have been quite out of the reach of the amateur. Today, however, a small radio telephone set, with a range of anything up to say 25 miles, is quite within the reach of the average pocketbook.

In any of our large cities we now come across several radio telephone stations that are owned and operated by amateurs who enjoy themselves by sending out radio concerts and talks that may be picked up by anyone within range and possessing a receiving set. Radio telephones are now being employed in certain sections for spreading the gospel, so to speak. A clergyman, delivering his regular sermon, can broadcast his voice over a wide radius and reach thousands of listeners by means of the present radio telephone.

Music can be broadcasted with little difficulty. In fact, manufacturers of radio apparatus may be expected in the no distant future to maintain regular broadcasting radio telephone stations for the purpose of furnishing music to the users of their receiving sets. At least one company plans to produce a receiving set made in the form of a cabinet phonograph, which, standing in the home of the user, may be tuned for receiving a sermon, speech, music, market reports, Government bulletins and whatnot when radio telephony becomes still more popular.

The United States Government has undertaken the broadcasting of information regarding the conditions of the live-stock and similar markets, in various sections of the country, for the benefit of farmers and live-stock raisers. This service is proving such a success that it will be expanded.

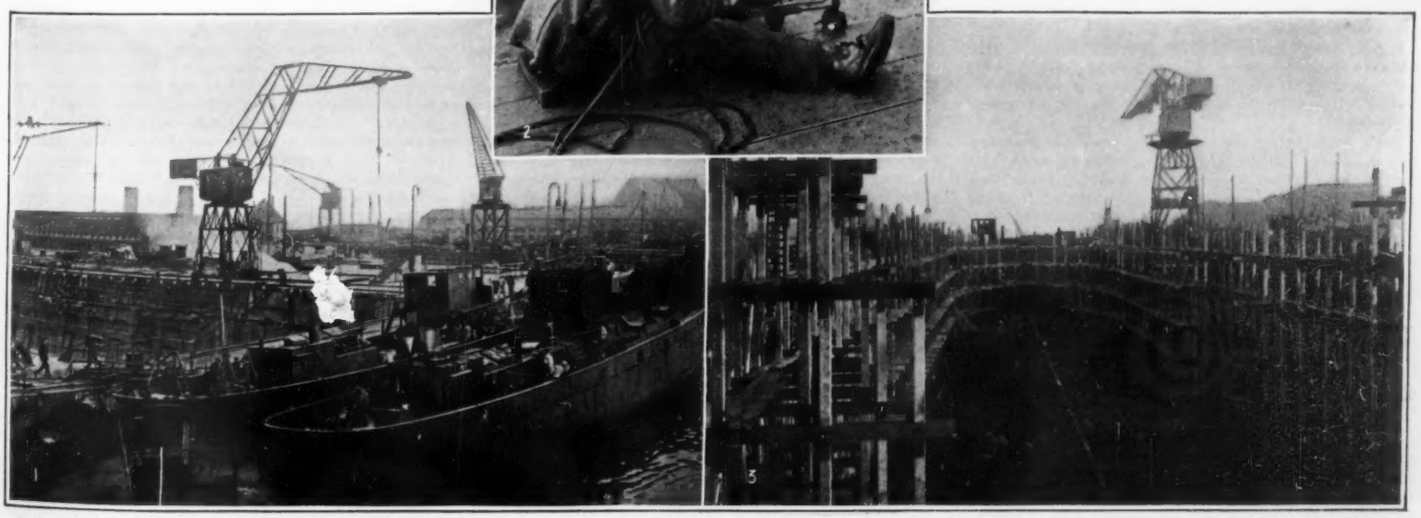
For the benefit of mariners the Bureau of Lighthouses of the Department of Commerce has established radio beacon stations, which are designed to function with as definite reliability and over as great distances as the lights and other signalling devices.

And all the foregoing, be it borne in mind, is available for the layman. There is no special code to master, while the receiving apparatus now available is so simple that anyone can use it. Truly, radio is now available for everybody.

Is it any wonder, then, that we find the camper making use of a radio receiving set to keep in touch with the world's happenings, or perhaps to secure a little music for the evening's entertainment? Instead of erecting a large aerial, the camper simply makes use of a large kite or a small balloon which is sent up with a long copper wire that serves as the receiving aerial. For shorter distances the amateur can obtain satisfactory results with a small outdoor aerial or even a dozen turns of wire wound on a square framework, making what is known as a loop aerial which is used indoors.

Trawlers for Battleships

ONE of the most significant transformations in Germany has been the wholesale reorganization of many of her largest industrial plants, formerly devoted to naval and military construction, and their adaptation to meet the peacetime demands of world commerce. We show three pictures taken at the well-known German Navy Yard at Wilhelmshaven, which indicate this transformation from war to peace activity. One of these represents the building of an 8000-ton commercial steamer upon ways which, formerly, were devoted entirely to cruiser and battleship construction. At this yard, also, there have been built since the Armistice several steel steam trawlers, four of which are shown in the foreground, adjacent to the pontoon gate of one of the masonry dry docks. It will be remembered that the Armistice conditions called for the breaking up of several naval vessels that were under construction at the end of the war, and one of our pictures shows a workman engaged in making a long cut through what looks as though it might have been a section of the side or deck of a war vessel.



1. General view of the wharf, where formerly only battleships were built. 2. Part of the work of dismantling a warship, and converting the material to peace-time uses. 3. Construction of an 8000-ton commercial vessel in the old battleship factory

Peace-time affairs at the Wilhelmshaven state wharf, once given over to naval construction

Twenty Miles a Day

Inadequate Terminal Facilities and Their Part in Our Freight Congestion

By John Lathrop

THE day of renewed industrial activity is admitted to be close at hand. With it will come again the familiar cry of "car shortage," with the citation of losses to manufacturers, merchants, farmers and others by reason of delay in receipt of goods, materials and products, and uncertainty caused by the uneconomically slow movement of freight.

I am aware that a vast majority attribute this habitually slow movement of freight to shortage of rolling stock and motive power. I affirm here that it is rather due to shortage of terminal facility, in the main, and that, not the purchasing departments of the railways, but only the engineering departments, will be able to correct that conceded defect in our system of national transportation.

Every engineer—every scientist, indeed—knows the "neck of the bottle" principle as applied to the flow of railway traffic; that the loaded cars of a railway system may not pass along the lines any faster than the terminals will permit; and that the movement of freight in normal years has for long been slow enough to give haulage by water through the Canal from New York to San Francisco in less time than that required for shipment, trans-continent, by land.

Probably not every one who has speculated on these matters has stopped to think that, in the very nature of the case, congestion could not be caused by car shortage—a proposition at once unscientific and absurd. Slow movement of freight and congestion are resultants from inadequate terminal facilities; from failure properly to engineer the lines. A failure not to be charged entirely to the railway financiers, but rather to the oncoming of that period wherein railway credit was weak, and capital difficult to be obtained.

We cannot, however, completely exonerate the railway financiers of the past from blame for the inadequacy of the terminals. Engineers have pleaded, and been refused funds, for terminal improvements, in years when the people of the United States (and for that matter of Europe) had abundant capital to sell to our railways for what use the directors wished.

With the dawning of the day of revived industry is it not timely to consider by what means the railways may best prepare, and how they may forefend against the continuance of the inordinate delays which have been so heavy a burden on American business and on the people? If the American railway house is to be set in economic order, the engineer will have to be given permission to go full scientific speed ahead, and provide that which will enable the lines to perform their economic functions.

It was fifteen years ago that the late James J. Hill declared that one billion dollars a year for ten years for improved terminals for American railways were needed to provide reasonable facilities for movement of freight.

Such engineering improvements were not provided. The engineers hailed Mr. Hill's pronunciamento with glad acclaim. They knew he had spoken truth. They knew that in no way other than by widening the neck of the bottle could freight movement be accelerated to that which might be regarded as an economical haulage distance per car per day.

Instead of giving heed to what Mr. Hill said with a world listening, and to what the engineers were saying each to his own superiors, conventions adopted resolutions denouncing "car shortage," and demanding that more cars be bought and more locomotives placed in commission. Even the Interstate Commerce Commission named a sub-commission to hold hearings at stated traffic center points, on "car shortage."

But these hearings developed that, not more cars, but better terminals, were the condition precedent to solving freight congestion, together with some reforms in loading and unloading practices. It came out at last that, were more cars bought, congestion would be worse. That that which was needed was to increase the miles per car per day movement. For, the true test of economical haulage is the number of miles per day we move our freight—and not the number of cars in existence which are loaded or ready to be loaded.

The best record of an American railway up to 1915 had been made by the Pennsylvania system—25.6 miles per car per day, a trifle more than one mile an hour. About that time, Mr. Underwood of the Erie put into operation that road's improved terminals, and soon achieved a per car per day movement of 31 miles.

However, the aggregate of American railways never attained an average of more than 16 to 17 miles per car per day; and in many years the average fell so low as 13 to 14. These freight cars, on a countrywide average of a little more than one-half mile an hour, were so slow-moving because (a) there was some delay in loading by consignors; (b) some delay in unloading by consignees; but (c) mainly, because loaded cars ready for haulage and empties ready for loading were detained in terminals where the glut was so great that the railway operating department could not move them out.

This is the clearer when one considers that American freight trains move up to 24 miles an hour, or at the rate of 576 miles per 24-hour day, while they are en route between stations. It is not necessarily faster train movement, more cars, more engines, larger trainloads, engines or cars, which must be had perforce to increase the movement of freight. It is true that, under a proper co-ordination of all facilities, larger equipment units may be economical. But vastly more vital to betterment of traffic flow is the terminal, which indeed is the *sine qua non* of improvement.

Imagine complaint of slow movement of freight through Harrisburg for the east and west. Imagine one hundred thousand new cars added to the complement of the Pennsylvania system, and fifty thousand of them placed on the tracks at Johnstown to move eastward to seaboard, and the other on the tracks at Philadelphia to move westward through the Harrisburg terminal. If the present supply of cars may not be moved through that terminal, how could a hundred thousand additional cars be moved through it? Manifestly, they could not be!

The 3,000,000 freight cars owned by American railways would cost to replace about $6,000,000,000, at least twice the pre-war cost. Their average capacity is about thirty tons. Loaded all at once, they would carry 90,000,000 tons just about 15 miles a day. Assume adequate terminal facilities to enable the increase of the per car per day movement to 30 miles—or to 1.25 miles an hour. Then 90,000,000 tons would move 30 miles a day, which economically would be the equivalent of moving 180,000,000 tons the present fifteen-mile average. The war period, of course, is excluded as abnormal and in a special class by itself.

In other words, we would be economically adding $6,000,000,000 to the capacity of the railways to deliver freight. And in still other words, we could (theoretically) buy not another car or locomotive, put all the money into terminals, and be ahead those six billion dollars, less the extra repairs on the cars as they grew older.

It is amazing how generally ignorant the public is in respect of the easily understood fundamentals of transportation. A South Carolina Chamber of Commerce actually appointed a strong, influential committee to induce the railway company to abandon its route around that city for through freight, and bring it into and through that city! "We want the business," they told the General Manager.

But, at the same moment, as a saving incident, the Chamber of Commerce of Syracuse was asking—demanding, indeed—that the through haulage of coal for Ontario points be routed around that city. The South Carolina Chamber failed, and the Syracuse Chamber succeeded, in its objective. But the railway officials experienced difficulty in convincing the southern Chamber of the fallacy of its reasoning.

And consider Chicago—greatest rail terminal in the world—with millions of through tonnage dumped into a stagnant pool where congestion foredooms it to remain, sometimes for months, until some leak may be infracted into the dam that it may flow onward to perform its seriously delayed economic function for the Nation. Why should freight Duluth to Cleveland, for instance, pass through Evanston and Chicago? And so on *ad infinitum*. Chicago itself would be signally benefited were all through freight routed so as never to enter that city. And so would any other city, the terminals of which are glutted with through cars destined to pass onward, the seals unbroken, to points beyond.

It is true that a beginning has been made—classification yards such as those near to Syracuse, and some routing so as to avoid congested terminals. But it is the judgment of railway engineers that the vitality of the issue is not appreciated to one-tenth of its importance by the general mass of railway financiers, operators, legislators and shippers.

THE automobilist will testify that, in order to average thirty miles per hour for his entire journey from start to finish, he must drive forty or even fifty when he is on the open road. The man who has tried to get from New Jersey to New York by ferry in his car of a Sunday evening will add his testimony to the effect that it is the ferry that governs the time consumed in the attempt, and in no sense the automobiles. Yet, curiously enough, when railroad freight lags behind the schedule which we have laid out for it in our minds, we are inclined to overlook the obvious explanation, and fall back upon the time-honored "car shortage" to solve the riddle for us. The fact is, our railroads are ordinarily handling about as many cars as they can comfortably handle; and any attempt to run more cars with the present facilities can have but the one result of still further lowering the average speed with which the cars move over the tracks. That, under what railroads have become habituated to accept as normal conditions, this average is as low as 15 or 20 miles per day, will surprise many readers; yet this is the fact. Mr. Lathrop is decidedly convincing in his argument that we must vastly better our terminal facilities before we shall ever be able to handle freight as it should be handled.—THE EDITOR.

Taking Sulfur Out of Coke with Hydrogen

FOR metallurgists the presence of sulfur in coke is very objectionable as is well known and the trouble is likely to become more serious with inferior coal. Most of the sulfur in coke comes from the pyrites, and the pyrites can to a certain extent, be removed by washing the coal. The washing does not affect the organically-bound sulfur, and it barely reduces the sulfur content of the coal by one-half in the best case. Various other means of getting rid of the sulfur have been tried, mainly by converting the sulfur into a compound which can either be volatilized or be eliminated by subsequent leaching. Heating of the coal with steam or air, with chlorine, sodium chloride, carbon monoxide or manganese dioxide has been proposed. None of these proposals has been adopted on a large scale, however, because they are either wasteful or too complicated.

In analytical practice coal can completely be desulfurized by hydrogen. For that purpose, the powdered coal is mixed with zinc or some other metal which will generate hydrogen on the addition of hydrochloric acid; this hydrogen changes all the sulfur into sulfuretted hydrogen, which escapes. It occurred to Alfred R. Powell, of the United States Bureau of Mines Experiment Station at Pittsburgh, that coal might be purified of sulfur by passing hydrogen through the coking mass. The experiments so far conducted are promising. But the coal must be heated for 3 hours up to 1,000 degrees Centigrade when hydrogen is used, and for longer periods if coke-oven gas is to be utilized, though some of the reactions take place at a temperature of 500 degrees. The experiments as yet have only been made on a very small scale, however, so that the practical difficulties remain an unknown factor. It will be interesting to note what is the outcome of these experiments, and what are the practical gains.

Japanese Veneer Paper

An Out-of-the-Way Product and the Simple and Ingenious Manner in Which It Is Made

By Samuel J. Record, Professor of Forest Products, Yale University

EVERYONE perhaps has seen fancy pasteboard boxes covered with a material that looked exactly like wood. One's first thought is likely to be that the grain of the wood has been printed on the paper. Upon closer inspection, however, it will be found that there is in reality an extremely thin layer of natural wood glued on to a paper backing. These wood veneers are as thin as tissue paper and a source of wonder as to how they can be produced in such large sheets.

The method of manufacture is the simplest imaginable. No expensive or complicated machines enter into its making. The delicate veneers are nothing more than thin shavings made by a large hand plane such as carpenters use. This plane is fitted with a blade 3½ inches long and nearly 6 inches wide, but except for the unusual size there is nothing remarkable about the tool. In order to secure the necessary pressure and relieve the workman from bearing down on every stroke it is customary to attach above the plane a long spring pole or bow of bamboo. Then about all the workman has to do is to shove the plane back and forth over the wooden block.

The wood commonly used is what is known in Japan as "Kiri." This tree is often planted in America for decorative purposes and is generally known under its botanical name of Paulownia. It produces the lightest lumber in the Far East, is very light colored, easily worked and keeps its shape so well under trying atmospheric conditions that it has a multitude of uses from shoes to furniture, for which no substitute is acceptable. The tree grows very rapidly when young and in eight or nine years attains sufficient size to be merchantable. Farmers find it profitable to grow these trees in with their regular crops and sell them when about seven inches in diameter. Older timber of slower growth is more highly esteemed but big trees are scarce.

For the production of paper veneers the trees are cut during their dormant period and the logs stored in cellars to prevent drying out. If the wood is allowed to dry it will be difficult to plane. When wanted for use the logs are cut into bolts about 24 or 36 inches long, depending on whether the veneers are to be used crosswise or lengthwise of the finished sheet. The bolts are quartered by splitting, knotty and defective parts are cut out, and the bark removed. Then without further treatment the quarters are placed in a clamp and the planing begun on one of the split surfaces. Later the block may be turned over and the shavings taken from the other surface in order to preserve the quartered effect.

There is a certain amount of waste at first but as soon as the shavings begin to come off entire they are taken in order and about 50 or 60 of them bundled together. These bundles are then boiled for about 20 minutes in a dilute solution of caustic soda (Na OH). They next are immersed for about five minutes in a solution of ordinary bleaching powder, and then washed in fresh water. After washing, they are soaked for a few minutes in a weak solution of sulphuric acid, one part to a thousand, to neutralize excess of alkali and prevent subsequent discoloration.

The next step in the process is to spread the shavings on a smooth lacquered board, three feet by four feet in size. The edges are joined by overlapping slightly, the surplus water is wiped off, and a thin coating of vegetable glue is uniformly applied. Dry paper backing or lining is then applied and smoothed down with a soft brush. Fancy paper with figures of flowers, butterflies, leaves or special designs in bright colors may be used and they show through the diaphanous layer of silvery wood with beautiful effect.

There are two stages in the drying process. The paper-backed sheets are first hung over a pole and air-dried in the shade. After natural drying is finished the sheets are gone over with a steam iron which smoothes out all irregularities and wrinkles. The satiny white veneer can be printed upon and some of it is pressed or calendered into fine corrugations to give a moire, pebbled or other fancy surface.

The finished sheets are graded according to grain or other special feature and put into packages of 200 sheets each. The weight of 200 sheets is about 5 1/3 pounds. Fifteen of these packages make a bale. The price per sheet, two feet by three feet in size, is from 2½ to 6 sen or about half as many cents.

The manufacture of veneer paper in Japan is confind to Yamagata City in the northern part of the island. In 1918 there were 13 manufacturers and the production was 8,250,000 sheets valued at 206,250 yen. Later the number of establishments was reduced to 10 and the output in 1919 was 6,500,000 sheets worth 227,500 yen, and in 1920, 7,000,000 sheets valued at 150,000 yen. The business furnishes employment to 300 people, of whom 100 are men, 120 are women, and 80 are children.

The market for the product is practically confined to Japan, Formosa and Korea, with little or no export trade. The paper is used almost exclusively for surfacing decorative boxes and containers. Rarely it is also pasted with good effect on the panels of interior sliding doors. It is sometimes used in the United States for covers of souvenir booklets, for menu cards and certain other special uses associated mostly with the lumber industry in an advertising capacity. If it could be had in strips of sufficient length it could be used for wall paper and interior decoration to good advantage in this country.

The Japanese name for this material is Kiri-gami (Paulownia paper), though some of it is put on the market under the name of Kiri-kyogi-gami, kyogi meaning veneer. Not all of it is made of Paulownia, however, and more highly figured woods, such as cryptomeria and elm, are occasionally employed.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

A New View of Einstein

To the Editor of the SCIENTIFIC AMERICAN:

I have read with much care Einstein's book on "Relativity." I regard Einstein as a humorist of high order, and shall take much interest in reading the remarks of your essayists to show that they understand him and belong to the immortal twelve whom he acknowledges. Singular coincidence—another great but serious Leader conceded He had 12 disciples who understood him. (Was there something racial and imitative in this?)

Percival Lowell was a great humorist and gained advertisement by claiming to make proofs of the inhabitation of Mars. I discovered that Percival was a humorist by reading all his printed works. King Solomon was a humorist—behind the scenes he nearly rolled off the throne laughing at his own decision on dividing the child. (How few understand this.) The Delphians were humorists. (What else?) Thales was a humorist. (See his joke about falling into a ditch while watching the heavens.) The Druids were humorists. (See their jokes about the moon as heaven.) Various humorists pretend to be trying to communicate with people on Mars. The author of "Cardiff Giant" was one of the humorists. Recall David Starr Jordan's story and joke about the *cat* and how all the wise men of the United States fell to it.

All mathematics, where it is not founded upon senses and the concrete, and where it does not keep true to the criterion of (common) sense has a border edge where you step into the absurd, unreal and impossible—(surds and transcendentals)—because mathematics is but a human invention by which we try to comprehend and measure a world without us *which has no mathematics*. Stepping from the concrete into the absurd and back again is "the humor of it" of the mathematical wise or *witty* man.

This feat Einstein does to advertise himself by his wit. He talks seriously on the concrete, then goes into the abstract or absolute, invents and adapts a little mathematics to go with it, then comes back into the concrete with a whole lot of new absurdities. (See clocks, bodies moving lengthwise, etc.)

His wit consists in stepping back and forth from the concrete and absolute so adroitly that most people fail to note the transition. It makes a droll result, and really is a fine wit. Having this "explanation" of "Einstein," read his "Relativity" again with the sense that you are perusing the work of a humorist, and you will see that your eyes are opened and that you understand "Einstein."

Providence, R. I. MINER H. PADDOCK.

Lightning in the South

To the Editor of the SCIENTIFIC AMERICAN:

I was much interested in the article on "Lightning" by J. Lachenbruch in the SCIENTIFIC AMERICAN of July 9th. Here in southern Alabama during July and August, we have thunder showers of more or less violence nearly every day.

Some phases of these storms are different from what I have observed in the North—at least in the Middle and Northeastern States. We have here the usual "chain" lightning which strikes preferably the yellow pines which have heavy tap roots. I have seen it stated that in the mountains of the Northwest the trees are not often killed by a discharge. I have never seen any trees here but what were killed outright. Sometimes clouds accompanying a thunder shower will pass over with a continuous humming growl and not necessarily with any perceptible discharge of either electricity or rain. The growl or murmur is apparently electrical as wind sufficient to produce the effect would be evident in disturbance of the cloud mass.

Mr. Lachenbruch speaks of "sheet" lightning as being only the reflection of distant chain lightning. That undoubtedly is often so, but our experience with storms here may explain cases where that view is insufficient. Down here in midsummer, or at the height of our electrical period, we have storms in which the whole cloud will glow at very frequent intervals with great intensity like a mercury vapor lamp. The color is usually white or yellowish but I have seen it when it glowed a light rose color, perhaps tinged with violet. An approaching or receding storm makes a fine sight when this glow passes from one part to another of its piled-up masses.

That this glow is not merely a surface electrification but is of the particles of the whole mass seems true because sometimes when such a cloud approaches the earth closely enough to become a fog the whole atmosphere around one seems on fire. When near the earth such displays usually "end with a bang," which, by the way, one is glad to hear as a proof of still being alive! When the clouds are higher in the air the glow will spread through one cloud to another with only a more or less continuous growl but louder and more distinct than the humming noise in the case I first mentioned. Almost every evening at this time of year one can see on the horizon, clouds burst into this electrical glow resembling the so-called "sheet" lightning so much that I have often wondered whether the latter might not frequently be mistaken for the glow lightning. In the North the glow form might be present only in modified intensity in the higher cloud masses which would only be visible at a distance as intervening heavy clouds would in that case shut it out from below until the storm was some distance off. W. RUSSELL JONES.

Satsuma, Ala.

The Speed of Birds in Flight

To the Editor of the SCIENTIFIC AMERICAN:

I have just read an editorial in the recent issue of your classic paper on the above subject, and I have one observation which may be of interest. Some years ago I noticed the speed of the flight of a wild duck in its course down one of the large western rivers. I was on a transcontinental train going down grade along the bank of the river. The river was straight for a considerable distance. It was late in the afternoon; the duck was alone in its flight, and I had the impression that it was working at about its maximum speed. I had plenty of time to observe its speed as it flew parallel to the train for three miles, and at very slightly greater speed. The occurrence was so unusual (to me), and the opportunity such a good one, that I made careful note of the relative speeds of the duck and the train. I took the time of the train in passing from one mile post to another and found the speed of the train was at the rate of fifty miles per hour. I carefully noted the leaves of the trees for any indications as to direction of the wind, but concluded that there was no wind. My conclusion was that the duck was flying through the air at a rate of from fifty to fifty-five miles per hour. The size of the duck was such that it might have been a mallard, but I could not identify it positively. W. M. WHITE.

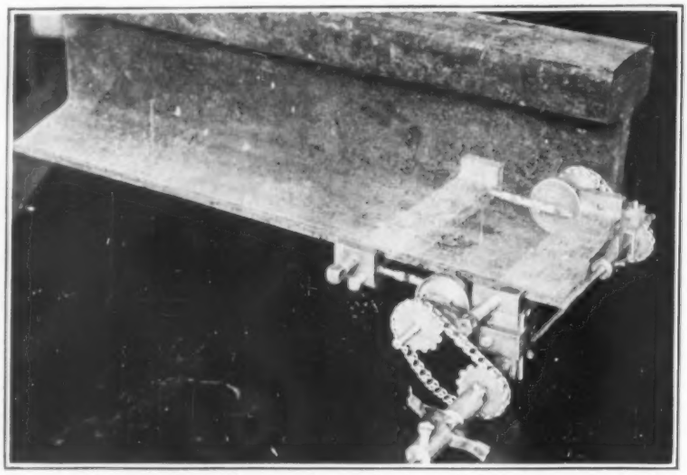
Milwaukee, Wis.

The Story of the Rail

How Scientific Tests Are Solving Some Outstanding Transportation Difficulties

By George H. Dacy

SINCE the inception of modern rolling stock, more powerful locomotives and improved roadbeds, the universal tendency has been for the railroads to overload freight cars without proper and complete knowledge concerning the stress and strain and wear and tear which the various types of chilled iron car wheels would withstand. Annually, innumerable failures of car wheels and even serious wrecks are due to this lack of the scientific standardization of the car wheel industry. Evidently, the railroads have been too busy to tackle and solve the problem as they largely have followed theoretical guesswork as a guide in many of their car wheel activities. The transportation department of the University of Illinois College of Engineering has set out to solve these problems as well as many others relating to railroad transportation riddles. In some of this experimental work, the college authorities are working in cooperation with the American Society of Civil Engineers and the American Railroad Engineers' Association, while in others the Illinois institution is doing free lance research work. Some of the railroad track studies have been in progress seven years and are the most complete of their kind ever attempted and consummated.



Close-up phantom view of the mechanism that conveys the impression of the rail strain from the rail to the recording apparatus

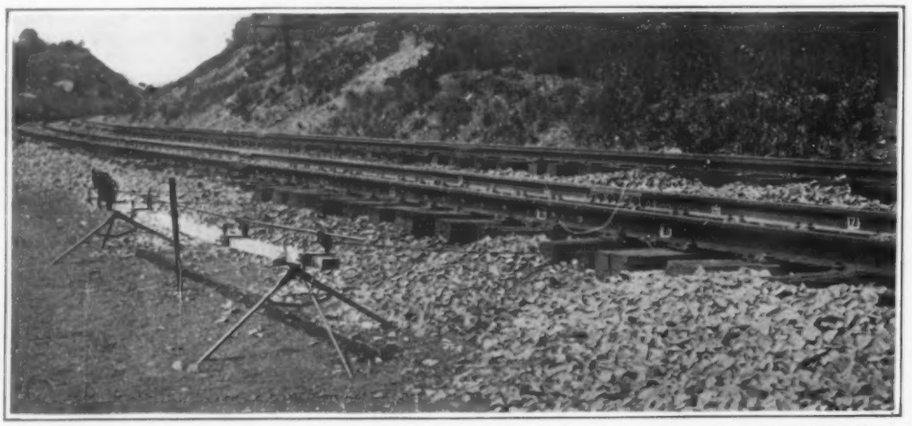
The car wheel tests at present in progress are designed for the definite determination of the various stresses set up in different parts of the car wheel when the brake is applied on a long mountain grade. This strain often is sufficient to disrupt and collapse the wheel and many accidents and wrecks on such grades are directly due to the lack of standardization and complete knowledge concerning the responses which the individual wheels will make to a wide range of stresses and strains. Stress and strain compensations, in many instances, are responsible for holding car wheels together, the disruptive operations of one agent counterbalancing those of another. When the chilled iron car wheels are forced on the car axle—they must fit very tight—an enormous stress is produced at the wheel center. Other stresses are developed with the application of the brakes. Chilled iron wheels are preferred by many railroads to all-steel wheels, because they wear better on steel rails and because they are cheaper.

The Illinois tests involve complete study of the strains developed in the wheel when the car load is transferred to the rails through the wheels, the compensating stresses which are produced in the wheels, and the loads which would collapse flanges under a wide range of conditions. The purpose of these tests is to ascertain positively what stresses are set up in the wheels under service, what shape and design of wheels will best meet these requirements, how thick the wheels should be, how heavy and what proportion of iron is necessary in the construction of the wheels to make them safe and durable. These car wheel tests at Champaign, Illinois, have already consumed five years' work as, at the outset, the investigators were working on new problems. There were no precedents to steer their experiments by. They had to devise and develop original testing machines which, under laboratory conditions, would permit of duplicating the wear, service and traffic conditions to which the car wheels would be subjected in actual service. The measurement of such stresses is a slow, time-exhausting process and it takes long periods of untiring effort to attain satisfactory and permanent results. In the test work, electrical contacts and thermocouples are employed to determine the temperature responses at all parts of the wheel under varying types of service, load, grade and braking. Special strain gages are used to measure the stretch and strain produced in the wheels in both the radial and circumferential directions.

The investigations of railroad tracks are performed partly in the laboratory and partly under actual field and service conditions. Very detailed studies of the rail, railroad crosstie, rail joint and ballast have been made. Under actual service conditions, all types of locomotives and cars have been studied operating at speeds ranging from one mile to sixty miles an hour. Special recording instruments have been devised which are attached directly to the rail; and by the use of glass-smoked disks and a recording pencil, a line is drawn on the disks when the rail is subjected to the strain of the load distributed over it when a locomotive or train wheel passes. The deviations of this line from a true circle are accurate indications of the stress, compression and stretch induced in the rail when subjected to the burden. In exceptional instances, a stress of as high as 50,000 pounds a square inch has been developed in the rail by the action of certain locomotive wheels. It is worthy of special mention that more than 400,000 microscopic readings were recorded during the summer of 1920 in the field investigational operations. Track tests were made on the Illinois Central Railroad near Champaign, on the Chicago, Milwaukee & St. Paul Railroad north of Chicago, on the Topeka and Santa Fe Railroad in Iowa and New Mexico, and on the Delaware, Lackawanna and Western Railroad in New Jersey in order to obtain results of countrywide application.

Research studies have been made of different types of locomotives to determine if they were properly designed and counterbalanced from a technical and scientific standpoint. Thorough studies have been made of why rails break under service and the results will be of great value in preventing the repetition of such accidents. The correct spacing of the drivers and other wheels has been investigated—up to a limit of six feet, the closer the wheels are the better for the rail. The effect of flat spots on car wheels and their action on the rail have been thoroughly investigated. Flat spots are particularly injurious to rails where the brakes of the car are abruptly and tightly applied, while such actions increase the damage to the wheel. Briefly, these detailed tests will result in the potential standardization of chilled, iron car-wheel design and steel rail utilization. In the future as a result of this experimental work, greater efficiency will obtain from the service of railroad trackage and car wheels.

The question of how heavy rails should be to withstand the traffic of different weights and types of locomotives has been covered and an intensive investigation of all types of rail joints to ascertain the proper length and shape has been completed. The railroad ties have not been neglected as they have been carefully scrutinized from all possible angles regarding their bend, their bearing in ballast, what happens if the ties are not tamped thoroughly or are tamped too much in one spot. Complete data have been obtained concerning the most efficient designs for steel and reenforced, concrete ties. Scientific observation of the ballast have included how the pressure is distributed downward from the tie through the ballast and laterally through the roadbed foundation so as to decide the exact amount of ballast essential for best results, particularly in cases where the roadbed is soft. For ordinary light traffic, gravel and cinders generally constitute satisfactory ballast, but where the traffic is heavy, crushed rock and broken stone are preferable. These tests will be continued and carefully rechecked until absolutely reliable data are obtained in conclusive amounts.



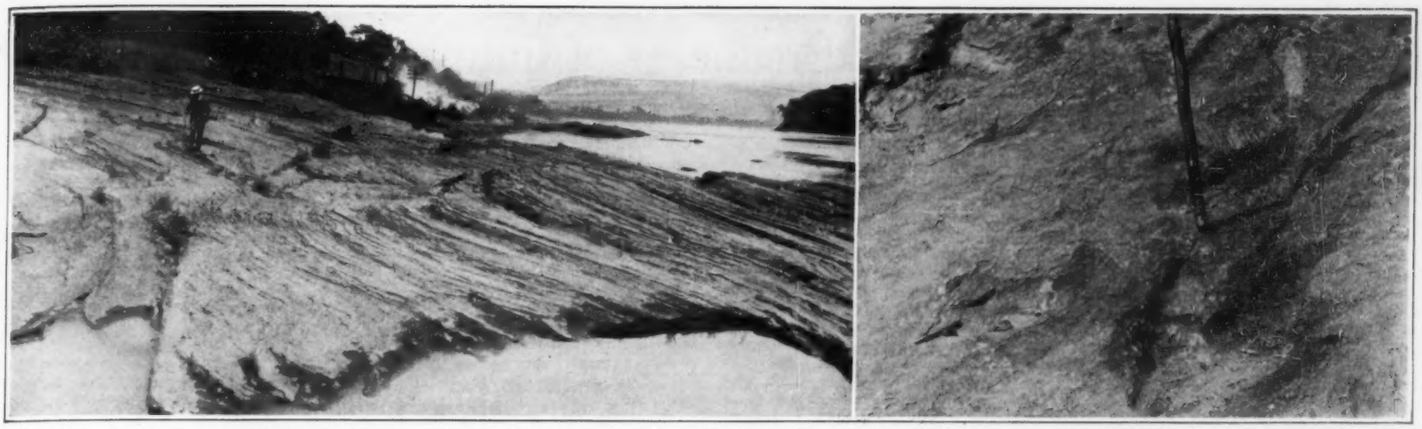
The rail-recording device, that gives smoked-glass graphs of the stress and strain produced by the passage of each wheel of the train

Explosions Caused by Aluminum Dust

THAT aluminum dust may be the cause of a serious explosion, similar to that caused by coal dust or other materials, is evident from a description of the circumstances under which a fatal explosion of aluminum dust took place in a finishing department of a plant making aluminum utensils.

The finish was obtained by polishing the utensils on lathes, the dust being collected in hoods feeding into a duct running under the bench and leading to an exhaust fan. This fan delivered the dust into a vertical pipe which had its discharge on the roof of the building. The explosion was due to a piece of No. 7 B. and S. gage iron wire which had somehow got into the discharge pipe and had come into contact with the blades of the fan, thereby, no doubt, creating a spark which ignited the dust. The explosion was fatal to the operatives working near the blind end of the suction pipe.

The new ventilating system provides for induced ventilation. The hoods collecting the dust from each brush are led independently outside the building, and clean air under pressure is provided from a pressure fan through a duct again running under the bench, this air being blown into the exhaust ducts coming from the lathes, inducing the necessary depression in the hoods. The dust is kept from contact with moving machinery and the danger of an explosion is practically eliminated.



Left: The rocks that were upheaved when Mount Tom was formed. It is in these rocks that the dinosaur tracks are found. *Right:* One of the prints, considerably longer and immensely broader than a human foot

The prehistoric Connecticut Yankee was a dinosaur, if the record of the rocks is to be trusted

Our Prehistoric Inhabitants

THE existence of tracks of dinosaurs in the Triassic sandstones of the Connecticut Valley has been known to geologists and to readers of geological literature for years. Many of us have seen such impressions contained in slabs of sandstone removed from the places where they were discovered and placed on exhibition in museums; and the tracks have often been pictured in books on geological subjects. Few of us realize, however, just how these impressions, made millions of years ago on the bottoms of broad river courses and along their banks by these prehistoric animals, came to be exposed to the inquiring eye of the observer today.

Ten millions of years ago, the Triassic, or lower of the three great divisions of the system of fossiliferous rocks which make up the Mesozoic series, was formed; and at that time there was no Mt. Tom or Mt. Holyoke to add to the beauty of the Connecticut Valley. In fact, the stream which we now call the Connecticut River did not exist, but in its place was a shallow stream bed which probably followed its present course. Some prehistoric animal, which scientists have now come to believe was the dinosaur, splashed through this river flood plain and left his tracks on the soft, muddy, rippled bottom. Eight millions of years ago, during what is known as the Jurassic period, the earth heaved, the Triassic sandstone was broken into segments and tilted up, and the foundations of mountain peaks now known as Mt. Tom and Mt. Holyoke were tilted into their present attitude. They were eroded and base levelled during the Cretaceous Period; and following this, the present valley of the Connecticut River was formed. Our photographs show this softly rippled Triassic sandstone, now hardened into a rocky formation, sloping down to the present Connecticut River; and here and there on this rippling surface may be seen slight depressions which resemble in outline the tracks of a huge three-toed bird. Some of them are slightly longer than the average man's foot and over twice as broad. Among these larger impressions is an imprint (about as large as a three-fingered human hand with the middle finger extra long) which may possibly be the track of a baby dinosaur, or, more probably, that of a smaller species of the same general character.

It is interesting to note in this connection that the members of the dinosaur family were not all colossal monsters. From skeletons of these animals which have been unearthed, paleontologists have established the fact that dinosaurs ranged in size from the height of a chicken to the nineteen-foot monstrosities which we ordinarily associate with the name of this prehistoric reptile.

From the position of these tracks on the rocks and skeletons discovered, scientists believe that dinosaurs were two-legged, not four-legged animals, and that in bodily outline and method of progression they resembled somewhat the kangaroo. The larger animals had a long sweeping stride; and it takes a long-legged man to step from one of their footprints in the rock to the next. Series of six or eight successive steps may be traced, but the trail soon disappears under a stratum of rock which may be removed in the future, or has been obliterated by the action of the weather or the thoughtless destructiveness of picnickers who have built their camp-fires over this hieroglyphic record of dinosaurian tribes which lived long before the human species made its appearance upon the stage of geological time.—By *C. M. Lewis.*

Old Peruvian Surgery

IN the American Museum of Natural History are preserved some skulls which show some daring examples of surgery practised by the Peruvian surgeons in the time of the Incas. The most remarkable example is a trephined skull which shows a clear case of trephining before death. This is considered as evidence of a remarkable knowledge of surgery among an aboriginal people. The skull was obtained from the Incan cemetery in the valley of Yucay and was for many years in a well-known collection in Peru, where it was visited by celebrated surgeons, who found the operation was not performed with a saw but with a burin or tool like that used by engravers. The opening is 58 one-hundredths of an inch wide and 70 one-hundredths of an inch long. The date of the skull has not been definitely determined, but there is no doubt of its ante-Columbian date. It is thought that the patient survived the operation anywhere from seven to fifteen days. The operation consisted of four linear incisions as shown in the engraving. The job was a good one and the bone was removed to the dura mater. The amount of bone removed was about equal to that which would have been removed by the use of a modern circular trephining saw. There was no fracture of the bone, therefore this surgical act was preceded by a diagnosis. It is believed that for some days before the operation there had been an effusion of blood under the dura mater. Whether the original or the modern diagnoses were true or false we conclude that there was in Peru before the European epoch an advanced surgery.

In addition, we show an artificial deformation exhibited by a flattened skull from Bolivia. This is also in the American Museum of Natural History.

Right: Artificially deformed skull of an adult of ancient Bolivia. *Left, Center:* Front and side views of trephined skulls from old Peru

Samples of Incan surgery, as practiced 500 years or more ago

With the Engineers of Industry

A Department Devoted to the Physical Problems of the Plant Executive

This department is devoted to business men, works managers, production engineers, and all other executives seeking the maximum efficiency in carrying on their work. The editor of this department will endeavor to answer all questions relating to plant equipment, factory management, and industrial affairs in general.

The Vacuum Cleaner in the Factory

THE vacuum cleaner idea has at last invaded the up-to-date factory, and is proving just as much of a time- and labor-saver there as it has proved in the home. The factory vacuum cleaner must of necessity be a heavier machine than the domestic cleaner. The present practice is either to have a portable cleaner mounted on a four-wheeled truck and available in any part of the factory, or to install a vacuum pump in some part of the factory building connected by pipes to the hose and nozzle in any other part. The collector tank, in the latter case, can be placed out of doors and in such a position that it can be emptied directly into a motor truck, wagon or dump car for ready removal.

Aside from speeding up the work of sweeping and cleaning, the vacuum cleaner does a far better job. It does not raise the dust as in ordinary sweeping; in fact, the dirt and dust are removed and not scattered in every direction. One man and a large vacuum cleaner installation can keep the average factory clean, safe and healthful.

Conservation of Steel Stacks Weakened by Corrosion

THE conservation of self-supporting steel stacks, which have corroded to the danger point, by encasing them with concrete has become a well-established practice. Engineers and owners of power plants should know of it. To demolish an otherwise serviceable stack simply because the steel shell has lost its strength by corrosion, when at comparatively small expense and without even shutting down the boilers, it may be converted into a permanent concrete stack would, in the light of present knowledge, be a great mistake.

Rather than tear down a steel stack, which was in condition requiring renewal, causing shut down of the pumping station at South Works, Illinois Steel Co., South Chicago, 1919, it was decided to use the cement-gun in reconstructing the stack. By coating the outside with reinforced cement-gun concrete, a new self-supporting stack has been built upon the existing foundation.

This steel stack was 175 feet high by 9 feet diameter. A reinforcing network of sufficient strength to make the new stack self-supporting without any help from the existing stack was built up of rods and wire mesh and secured to the existing foundation bolts. A cement-gun was then used to shoot guncrete or gunite, as it is variously called, through the reinforcing mesh against the existing steel shell to the required thickness. A mixture of sand and cement hydrated in the nozzle was applied with an air pressure of about 35 pounds. The guncrete is 18 inches thick at the base, tapers rapidly to 6 inches just above the bell base and then gradually decreases to 4 inches at the top.

The cement-gun remained on the ground. The dry mixture of sand and cement was blown through the hose by air from a compressor working at about 50 pounds pressure. Water was forced through the water hose of relatively small size but considerable length and at a pressure great enough to give a pressure at the nozzle in excess of the air pressure. The operator worked upward from the bottom, finishing as he went, so that at the end he was 175 feet above the gun and material was forced up to him at the nozzle at that point.

All the work was done without interrupting the use of the stack. The guncrete was applied when the stack was too hot to permit holding the hand against it. The breeching extending from the side of the boiler house to the stack was also encased with 3 inches of guncrete while it was so hot that water thrown against it boiled. The guncrete was kept thoroughly sprinkled until set. The effect of the hot stack seemed to be that of steam curing and after being in use for nearly 3 years the guncrete is everywhere sound and shows no cracks.

Some Facts About Shop Lighting

BLINDFOLD even the most skilled mechanic and he is helpless. Any piece of work which he attempted to do would be spoiled, and he would be liable to injure himself or some other workman.

Workmen in a poorly lighted factory are, in effect, partially blindfolded. The process of manufacturing goes on, but certainly not as efficiently as if adequate light were provided. Yet many manufacturers who supply their employees with the best of tools and equipment fail to consider the importance of the worker's eyes and the handicap of poor lighting. The efficiency of the workman determines the efficiency of the machine. Adequate illumination is an essential factor in securing high efficiency of the workman.

Inadequate and improper illumination increases the probability of accidents. A careful analysis of 91,000 accidents showed that about 24 per cent were due wholly or in part to poor lighting.

While most employers and employees are familiar with the dangers to the eyes from mechanical injury, very few are aware of the harm done by poor lighting. Impairment of vision is a slow process, and it may take months and even years before the individual becomes aware of it. Fatigue and eyestrain, caused by improper lighting, will lead to nearsightedness, then to a gradual decrease of vision, and possibly to total blindness.

Good lighting is an investment, states the National Safety Council, not an expenditure. In a plant which is properly illuminated accidents are less frequent; the employees work more efficiently and make fewer mistakes; a closer and better supervision of the men is possible; and the employees are contented and more stable in employment because of the orderly and pleasant surroundings which are sure to result from good lighting.

Adequate daylight illumination, properly applied, is the ideal light for the eyes. Light from above is generally better than light from side windows only. Skylights and monitor windows should, therefore, be provided wherever possible. Large window areas, equipped when necessary with awnings, window shades or blinds, and diffusive or refractive glass, together with light interiors, are desirable in every work place.

The light should be adequate for each employee. The illumination intensity should be at least twice the minimum specified for artificial lighting.

The skylights and windows should be so spaced and located that daylight conditions are fairly uniform over the working area. Saw tooth roof construction gives an ideal daylight distribution.

The intensities of daylight should be such that artificial light will be required only during those portions of the day when it is naturally considered necessary.

To avoid glare due to the sun's rays and light from the sky shining directly into the eyes, window shades or other means should be provided where necessary.

Ceilings and upper portions of walls should be kept a light color. The lower portions of the walls may be darker, to rest the eyes.

Machines and work benches should be placed to secure the best light available. Benches at right angles to wall will often be found to improve lighting conditions. Close machine work and bench work should be placed nearest the windows and the coarser work in center of room. Machines should be so placed that the light reaches the workman from the side and falls naturally on the work, and that operators, benches, and machines interfere as little as possible with the proper distribution of light to others farther from the windows. Lighting is improved by the removal of overhead belting.

Wired glass is recommended for practically all factory and mill windows where prisms are not required. Prism glass is of advantage where the windows are obstructed by buildings, especially if the room is deep. By its use a better distribution of the light over the floor area is possible. Wired glass should be used in all skylights as a safeguard against breakage. Ribbed glass gives better diffusion than plain glass; in vertical windows it should generally be placed with the ribs horizontal, and will then act somewhat like prism glass.

Artificial light is required in factories and shops, on an average, about 20 per cent of the total working hours, not including overtime or night work. Where night work is carried on, the artificial lighting problem must, of course, receive particularly careful consideration. The development of new and improved types of lights, in many sizes, makes it possible to secure satisfactory and adequate illumination in any industry and under varying conditions.

In the *direct lighting* system, which is most commonly employed, the light from the lamp shines directly on the object to be illuminated. Reflectors or enclosing globes are used to improve the light distribution, and to diffuse the direct rays from the lamp. With open reflectors, the glare from the lamp and reflectors is minimized by frosting the lamp or interposing another diffusing medium and by the use of reflectors of large area.

In *indirect lighting*, the work is illuminated by light reflected from the ceiling and walls. The glare from the lamps is avoided, the reflected glare from glossy surfaces is reduced, and shadows are greatly softened. Indirect lighting is the nearest approach to daylight. The new developments in incandescent lamps of high efficiency have reduced the operating cost of indirect lighting and increased its use.

Semi-indirect lighting combines the features of direct and indirect lighting systems. An opal glass bowl is used below the unit and permits a part of the direct light to pass through, while other rays are reflected to the ceiling and walls. By varying the density of the opal glass bowl, various degrees of direct and indirect illumination may be secured. This system is rarely used for industrial lighting but principally for ornamental purposes.

Local lighting alone should never be used, except for a few special operations. A moderate degree of general lighting from overhead lamps should be supplied even if local illumination is necessary at the machines; but whenever possible a system of general illumination only should be used, as this gives the most satisfactory results. Bare lamps should never be used as local lights at machines because they tend to blind the workman and in most cases shine more strongly into the eyes of the man than on the work. A deep reflector which envelopes the lamp so that no portion of the bright filament is visible, should always be supplied. This will keep the light out of the eyes and will concentrate it upon the work, thus permitting the use of a smaller lamp and saving electrical energy.

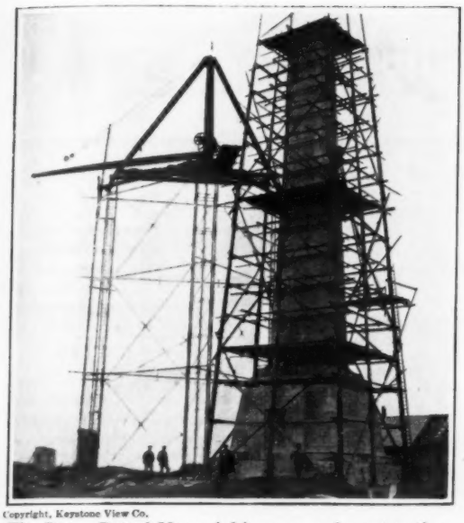
Photography in the Industries

THE possibilities of applying photography to industrial and business routine have only been touched. For it is certain that there is no better or more rapid manner of copying maps, plans, records, drawings, tracings, blue prints, valuable documents and other things than by means of the special cameras now available for just this class of work. Furthermore, the copies can be made to almost any scale, with relation to the original.

No plates, films or even a darkroom are required with the special copying cameras, in order to obtain a perfect photographic copy. All the objectionable features of ordinary photography are eliminated. Copies of any and all written, printed or drawn matter, whether contained in loose sheets or bound volumes, can be made in a moment's time. Direct, durable permanent copies from any sized original, can be made actual size, enlarged or reduced as desired.

The Built-In Electric Motor

LITTLE by little the electric drive has been developed into the built-in motor idea. That is to say, the electric motor, instead of being placed on the ceiling, floor or wall and connected with the machine by means of a belt, is now built right into the lathe, disk grinder, jointer, tenoner or other machine. Thus the machine becomes virtually a self-contained unit, with all the advantages that such construction implies. Furthermore, there can be no danger of using the wrong motor, since the motor is built right into the machine at the factory.



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The Dover Patrol Memorial in course of construction, which has called for 700 tons of granite

The Dover Patrol Memorial

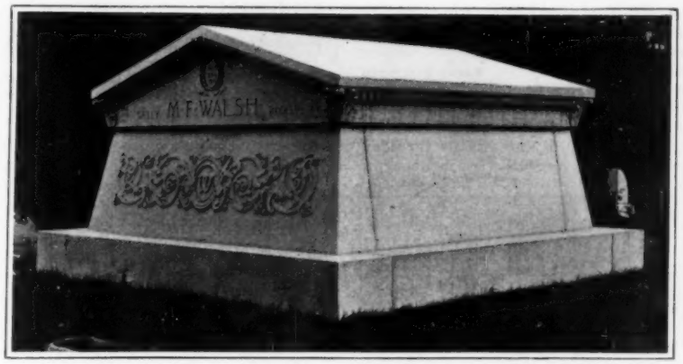
THE Dover Patrol Memorial has recently been completed. It is in the form of an obelisk, as may be noted in the accompanying photograph which shows this monument in course of construction. The obelisk is 84 feet high, the base is 21 feet on each side of the square, and the stone shaft gradually tapers off to about 5 feet at the top. Seven hundred tons of Norwegian granite have been used in the construction of the memorial.

Dog's Acre Beautiful

THE train stops for a moment to let off a few passengers at Hartsdale and hurries on. One party evidently in deep trouble and carrying a somewhat heavy box, enter a waiting automobile and are whisked away up the hill. If we follow them we soon reach a 5-acre cemetery on a delightful slope of one of the Westchester Hills just north of New York City. We might expect to see the hearse and all the panoply of woe, but they are lacking, although real sorrow is there, for we have reached a burial ground for deceased pets, otherwise a "canine cemetery."

The dog shares equally with the horse in man's friendship, and man's intimacy with the dog is apt to be much greater. Now, when a dog is sick he is taken to a hospital where an expert veterinarian attends him without cost to the master, and if he finally succumbs he can rest for all eternity in a permanent resting place with others of his kind. Previous to 1896 the disposition of deceased pets was a disturbing problem to the one-time owners. If they lived in the country they might bury "old dog Tray" in the garden, but if they sold the property the tiny grave over which the children had shed many a bitter tear, was lost.

Entering the gates we find a cemetery not looking very different from those where human beings are interred, except that the plots seem a little smaller and the tombstones are of modest dimensions. Here anyone can buy a few square feet, the minimum-sized lot costing $15. A moderate charge for "opening the grave," etc., is made so that the expense is not prohibitive, and even shop girls and coal drivers have been known to buy small plots for their beloved pets. Of course, those who wish larger spaces can be accommodated, and very large and choice plots can be had as high as $2500. The cemetery is open to animals of every description, so here we find canary birds, cats, horses, and even a pet lion once owned by Princess Lwoff-Parlaghy. Cement dog coffins are inexpensive, and are made on the premises; but metallic zinc caskets are provided for those who wish to spare no expense for the last rites for their pets. Some of the tombstones show what a grip dumb animals have on their owners. Here are a few epitaphs: "Mignon, dearest and best friend"; "Willie, one of my dearly beloved pets"; "Bessie, ever faithful and true, loved by all"; "Our dear little comforters 'Jou Jou' and 'Daisy'"; and so on. Some of the more aristocratic inhabitants of these silent acres are interred in pretentious mausoleums costing as high as $12,000. This cemetery is now 24 years old and there are upward of 3000 interments. On Sundays there are often 500 visitors, and 37 automobiles have been counted outside the gate at one time. These figures are significant as showing what an appeal domestic pets, especially the dog, have for us, and this feeling knows no boundary or language. Similar cemeteries are found in England and France, and as we gathered our facts, in came a request for information from Japan. There is no East or West for the dog.



An expensive mausoleum for a dog, which is typical of the more elaborate graves in the Hartsdale Canine Cemetery

General view of a corner of the Hartsdale Canine Cemetery, which is located on the slope of one of the beautiful Westchester hills, just north of New York City

Wearing the Scales for Good Measure

THE lemon picker shown in the accompanying illustration believes in efficiency. At least, in determining his daily wage he must keep track of how many pounds of lemons he has picked, and this calls for constant weighing operations. To this end this ingenious picker has made a simple shoulder strap arrangement to which he attaches a spring balance. It is but the work of a moment to fasten a pair of wire hooks to the fruit boxes and get the weight.

A lemon picker who carries his weighing outfit with him, strapped from his shoulders

A Milk-by-the-Can Plan

IN high cost of distribution, milk is everywhere a leader, and the margin between production cost and retail price is so wide in many cities and large towns that it is not such a very difficult matter for the nearby producer to sell direct to large consumers at a substantial price reduction, yet make an excellent additional profit himself. Large-quantity customers are necessary. With them, delivery and collection labor is a low minimum. Without them, serving many small users, the producer becomes essentially a retailer, subject to the expenses which make distribution cost ordinarily so high.

In a Boston suburb a unique business in milk direct from farm to consumer on a quantity basis is done successfully by a Townsend Harbor farm. This farm has some forty customers, each of whom takes an 8½ quart can every other day. The customers are restricted to a teritory easily served. Delivering by auto, a high school boy covers the entire route in about an hour.

And the price charged for milk is 12 cents—several cents below the regular Boston price. In fact, the dairyman doing this business figures that he saves his customers $24 a day.

In securing customers, this farm distributed a circular in which it explained that the principal reason for the high retail milk price was the service the customer demanded of the retailer. "You can be your own milkman," he declared.

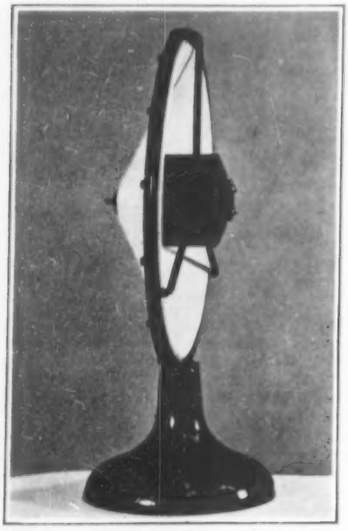
"We will deliver an 8½ quart can of milk that will keep sweet for several days. It is from a tuberculin-tested herd, safe and pure. It is rich in butter-fat. We supply milk bottles. You empty the big can into bottles, slip on the caps and set them on ice. Two days later, or four times a week, we call for the empty can and leave a full one. You get this splendid milk for $1 a can.

"You can share it with the lady upstairs or next door if you cannot use four quarts a day. You pay once a month. We reserve the right to refuse your order—we only have one private herd—or put you on the waiting list, and also to refuse an order on the basis of territory. We cannot afford to go too far to fill an order."

This plan, handled by the originator, works well. There is good business sense in it, and it ought to succeed quickly in many places, during these days when nearly everybody is looking for practical ways to cut down expenses. It is good because in eliminating service it puts nothing on the consumer which the average housewife can't readily attend to. Emptying milk from a large can to bottles is a little thing in itself, but it is the collective performance of such "little things" that adds much to the retail price.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Loud-speaking telephone that makes use of a cone-shaped parchment diaphragm

Something New in Loud-Speaking Telephones

THE above illustration represents an attempt to get away from the usual principles of loud-speaking telephony. The inventor in this case has aimed at a purity of sound that is not obtainable with devices that make use of metallic diaphragms operating in confined quarters and subject to all kinds of parasitic sound waves and impedances due to air compression.

The present device, it will be noted, makes use of a large parchment cone which acts as the diaphragm and horn combined. At the apex of the cone is an armature, which is actuated by a pair of electromagnets contained in the casing mounted on three arms and centered in the parchment cone. As the current fluctuates in the electromagnets the diaphragm or parchment cone is accordingly vibrated, reproducing certain sound waves. Because of the absence of a definite pitch in the parchment cone, the sounds produced by it are not subject to the distortion that occurs with metallic diaphragms which have a fundamental pitch of their own. The present device is suitable for the reproduction of phonographic music, in conjunction with a special microphone attachment, for addressing a large gathering, for radio reception purposes, and for all kinds of work calling for a loud-speaking telephone.

New milking stool which may be carried by putting one's arm through its seat

The Milking Stool Brought Up to Date

THE last word in a milking stool is a *stable* product. Sounds like a pun? Yet anyone who has ever milked twenty bovines and tried sitting upon a little flat, square board, supported precariously by one wooden peg under the middle will recall how *unstable* a pedestal it was. Modern sanitary science asks for a clean stable, a clean cow, and cleanliness in the person, clothing and equipment used by the milker in order that germ-free milk from the producer, Madam Cow, may not be contaminated before it reaches the ultimate consumer.

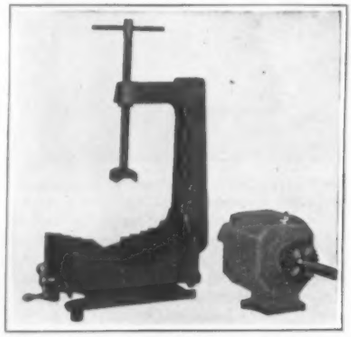
Should the new stool become soiled it can be washed, even boiled, for it is made of aluminum strengthened by an alloy. It weighs but two pounds and can be shipped in a compact parcel and assembled by bolts. The concave seat, which is merely a wide rim with a hollow center, is comfortable to use and convenient to carry upon the arm, leaving the hands free to carry the foaming milk pails.

An Automatic Kitchen-Hand

THE latest attempt to help out the hard-pressed housewife takes the form of a universal electric motor and stand which can be made to serve for a large variety of duties. Thus the motor and stand may be applied to the arduous task of grinding the ice cream freezer or beating a mess of eggs or stirring a large batter of dough for bread or cake. It may be applied to driving the meat chopper or polishing the silverware. A small grinding wheel driven by the motor serves to sharpen the various household knives, scissors, tools, and even the blades of the lawn mower.

A New Test Vise for Electric Service Work

A NEW test vise for use in testing generators, starters and ignition systems has been recently developed by a Chicago manufacturer. The deep recess in the bed plate of the vise automatically centers a round instrument under the take-up screw, while a square or irregular shaped instrument is held on top and against the side of one of the flat steps and is then held down securely on the bed plate by the threaded screw in the gooseneck. Adjustment of the driving belt or chain is secured through a 6-inch movement of the bed plate, operated by the ball crank handle on the front.



Special vise for holding a motor or generator in position while it is tested

A Grinder Used for Snagging Castings

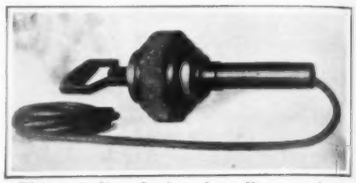
FOR snagging castings it is essential that a grinding device combine large amounts of power with light weight. This grinder, just introduced by a Massachusetts manufacturer, consists of a shaft with a handle on each end. Inside of the shaft is a switch and a wheel with its mountings rotates on the shaft. The mountings for the wheel are used as the motor, which is of the squirrel cage type, but reversed so that the secondary member of the squirrel cage construction rotates around the winding instead of inside. This rotating member consists of a thin shell of malleable iron carrying the bars of copper. The wheel flanges and end plates are of steel so as to carry the magnetism. The current flows through the copper bars across the copper-lined end plates to the copper bars opposite. In this way every part of the rotating member is used to carry current, magnetism, or both, except the wheel itself. The very nature of the electric motor and the principles on which it works leave room for much ingenuity on the part of the designer; the present model takes full advantage of the possibilities.

This motor-driven stand can be applied to all kitchen tasks, from making ice cream to polishing silver

Doing Away with Rewinding in Motion Picture Projection

AFTER a film has been run through the usual motion picture projector, it is obviously necessary to rewind the film on to another reel in order to restore to its original form. This process is expensive, time-consuming and helps to wear out the film. From time to time ingenious mechanisms have been introduced with a view to eliminating rewinding, and we have the interesting apparatus shown in the accompanying illustration to add to those that have gone before.

The present mechanism takes the place of the lower magazine of a motion picture projector. The basic principle of this invention is a rotary contracting drum which winds the film from the outside and finishes in the center by means of ten fingers which travel with the drum and hold the film outward. As the film builds up the fingers yield inwardly and at the point where the film enters, these fingers are lifted and lowered again by positive cam action.



This grinding device virtually contains the driving motor inside the grinding wheel

The schoolboy's trick of winding his strap into a compact reel, by inserting the plain end through the buckle and running it round and round the inside of the loop thus formed, is not too different in principle from the new device to suggest that boyhood experience may have furnished the necessary inspiration to the inventor.

The inventor of this device claims that the creepage usually taking place when the film is wound upon the lower reel of a standard projector is overcome in this device. The creepage has a tendency to scratch the delicate emulsion of the film, during projection and during rewinding.

With this new device the film is taken from the motion picture projector and inserted about two inches into the reversing reel. No fastening whatever is required, as the fingers hold the film down, thus keeping the film from creeping. The film is not wound in a round form but is pulled from point to point, inside the fingers, thus winding the film in the form of a decagon. The film also runs over an automatic governor which keeps the film at a very light tension, this tension being maintained constant from start to finish. Each machine is equipped with special core reels. One-half of a reel is placed in the machine before winding and when ready to remove the other half is snapped on and the film is then pulled out, ready for immediate showing. Rethreading, in case of a break in the film, is said to be greatly simplified.

Winding a motion picture from the outside to the inside, so as to avoid rewinding

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Pennsylvania's Roads

(Continued from page 144)

into the buckets of the concrete mixers.

Another result of this in addition to the marked improvement of the finished road and the reduction in cracks is that it speeds up construction. Records from which might be struck an average of day runs are not yet available, but under the present system engineers say there has been a decided increase in this average. On one typical job—that on the West Chester Pike previously referred to—a gang of forty men has been averaging 365 feet of new road every day of twelve hours. The minimum day run has been about 300 feet, the maximum 506. Five trucks operate with this gang. One section of two and a quarter miles for which the contract allowed one hundred days was finished in thirty-three days.

With the dumping of materials direct from trucks to the mixing machine a second handling is eliminated. The curing process in Pennsylvania follows the general modern highway engineering practice in other states. Roads are leveled with a template and the morning after completion the day's run is covered with gravel and rock. This is sprinkled daily for eight days to permit the concrete to dry uniformly. The covering is left on for twenty-one days, by which time the road is ready for use.

Engineers at work on the system say that cracks in the concrete are running from three to six a half mile, but in nearly every case, under the new specifications in effect this year, the fissures are slight and appear only in the two-inch surfacing above the wire reinforcement. These are filled at once with the asphalt mixture used in making the expansion joints and so far cracks so treated have not shown any appreciable widening. Last year the concrete road cost in Pennsylvania went up to $60,000 a mile, an increase of nearly $25,000 over pre-war figures. The total cost for the mileage under construction this year is not expected to exceed $50,000 and on some sections is considerably lower.

On grades of eight per cent and lesser grades running on sharp curves the Department is laying a paving of hillside brick, cut to afford a grip to the caulks of horses, on a base of six inches of concrete. The brick used is made of shale, with a wire cut lug, and is grouted in with cement. On this type of road the mixture for the concrete base is one part cement, three parts sand and six parts stone. For the plain and reinforced concrete roads the mixture is one part cement, two parts sand and three parts stone.

A Problem and Its Attempted Solution

(Continued from page 146)

the new design. It contains copies placed in the compartments about four months before the photograph was taken; it was in no way "dressed up" for the purpose of taking the view. A comparison between this picture and Fig. 1 is a complete demonstration of the difference between the customary and the newly worked out means of storing copies. The patents in both cases show the results of four months' pulling from groups which at the beginning of the period were in perfect alinement and proper sequence.

The case illustrated in Figs. 2 and 3, while demonstrated practicable and vastly superior to the old way beyond any possibility of doubt, is a long way from being standardized as the regular Patent Office procedure. This case is not of cheap construction; on its face it costs considerably more than open bins of equal capacity. Extensive installation of this style of equipment cannot proceed without special provision for it in the regular appropriation or in a special bill. The Patent Office, since the demonstration of the advantages of the new-style case, has managed to provide enough cash out of its extremely circumscribed funds to install eight of the units shown in Fig. 2. These eight units will hold eight weekly issues of patents. Perhaps the implication that the Patent Office every week issues enough patents to insure that a stock of the copies *will* fill a case of these proportions will be illuminating to some who had not realized the scale upon which Patent Office operations are carried out.

The ideal, of course, would be the provision of sufficient money to enable the Patent Office to store its entire stock of copies, within a reasonable time, in filing cases of this character. This ideal it is hoped will be approached when the efficacy of the new equipment will be demonstrated beyond question. With the appropriations that are available for the present fiscal year beginning July 1, 1921, an installation for almost a year's use may be instituted. Whether appropriations can be obtained for the 1,400,000 bundles of patents already granted to take them out of the old, inadequate, insufficient and expensive conditions in which they are now stored is a matter for hope and future determination.

The point, however, is obvious. Copies and copy-pulling has always been the skeleton in the Patent-Office closet, for the very excellent reason that no method of storage has ever before been known which would make the storage and the pulling clean and precise. Now such a method is known, and at the disposal of the Patent Office. It has been demonstrated on a scale small enough to be sure, yet large enough to give foundation for the estimate that if the entire installation of patent files were of this latest type, a reduction of force of 30 per cent in the copy-pulling branch of the Patent Office could be made with a reduction of inaccuracy of 90 per cent. It is difficult to exaggerate the loss to commercial interest by the report that a certain patent is "out" when it is merely out of place, and the loss to the Government through the reprinting of patents that are thus erroneously reported to be exhausted. Along with these gains, there would automatically come a material reduction in the extent of executive supervision of copy storage and copy pulling, an appreciable increase in revenue from the sale of copies, and an immeasurable improvement both in the quality and the speed of the service to the public. Finally, if the framing were of steel instead of wood there would be attained a favorable condition not now existing in the miles of inflammable shelving spread through the corridors and galleries of the Patent Office. But of course the immediate problem is to obtain equipment that will permit service; collateral advantages are of merely collateral importance. The way has been shown how to dispose of this vexing Patent Office problem for all time; it is to be hoped that Congress can be made to see the wisdom of making it possible for the Patent Office to put into effect the solution thus offered.

The Largest Crater in the World

TWO Swedish scientists named Waddell and Ygberg recently made a journey of exploration through Iceland with the interesting result that they discovered the largest volcanic crater in the world. It took them nine days, using three horses and sledges to cross the great sea of ice of the Watnajokel from west to east in order to reach Kolar on the Fjord of Hornar. Upon the Högjökel they found a tremendous volcanic crater containing hot water and no less than 8 kilometers long and 5 kilometers wide. It was surrounded by a number of hot springs. The Swedish savants who discovered it named it the Svea crater, and it is regarded as not only the greatest crater in Iceland but probably, so far as is known at present, the largest in the world.

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થી ઘણો ફાયદો થાય છે.

Timken's International Law

Not only in the United States, but in every country where well built American and European automobiles, motor trucks, and tractors operate, Timken Tapered Roller Bearings, in an ever ascending majority, are consistently conserving power

The original Parsi, and the American translation, of a Timken Bearing advertisement appearing in *Jam-e-Jamshed* of Bombay

THE TIMKEN ROLLER BEARING CO, CANTON, O

Timken Tapered Roller Bearings for Passenger Cars, Trucks, Tractors, Trailers, Farm Implements, Machinery, and Industrial Appliances

TIMKEN
Tapered
ROLLER BEARINGS